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SIGNS OF SPRING.

March is the first spring month, and although, according to the calendar, spring does not come until toward the end of the month, every one watches eagerly for signs of spring as soon as February has passed.

One of the first signs of spring which reaches the electric trade is the appearance of circulars describing the newest types of electric fans. These have already made their appearance, indicating that now is the time for the supply houses to begin thinking of their spring and summer orders.

The electric fan has hosts of friends and very few enemies, and is always a welcome addition to an office equipment or home furnishings. Even now, when we are not yet out of the grip of winter—for, as we write, snow is falling—this little forerunner inspires us with the hope that spring will be on time, and that this winter will soon be merely a memory.

IS THE STEAM LOCOMOTIVE DOOMED?

Is the steam locomotive doomed? Will not every steam locomotive now in operation soon be consigned to the scrap heap? Will not locomotive works have to go out of business, or turn their energies in other directions, such, possibly, as the building of electric locomotives? How many times these questions have been asked of late, and how often attempts have been made to answer them.

Of course, no general answer can be made to any such questions, but for some time to come the problem will be mainly one of dollars and cents, and while the electric locomotive will find plenty of work to do, the steam locomotive will, we believe, hold its own over the greater part of the railway systems of this country. That this opinion is held by prominent railway engineers has been shown by some recent large orders for steam locomotives. The latest of these was announced the early part of this week, when information was given out that the Baltimore & Ohio Railroad Company had authorized the purchase of 250 steam locomotives. One hundred and seventy-five of these are locomotives of the largest size; thirty-five are modern passenger locomotives. This company evidently expects to use steam locomotives for a time, at least, although it was the first road to employ the electric locomotive for hauling standard passenger and freight trains.

INVENTIONS AND INVESTMENTS.

We Americans have a way of patting ourselves on our backs, figuratively speaking, because we believe that we alone of all peoples recognize the true value of the scrap heap. We pride ourselves on always keeping in the front rank of progress and because we do not hesitate to condemn an old machine when one of a newer type is procurable. No effort is spared to keep our industrial plants in step with the inventor, who, in turn, is carrying the art forward as rapidly and as far as possible.

Now, undoubtedly, this spirit had been an important factor in carrying the country to the position it now occupies, and it will keep us in the front in the future. But it is also true that the principle of scrapping may be carried to excess. It may not always pay to discard an old machine and install a new, however efficient the latter may be. Although, considered alone, the new device may seem to offer a profitable investment, it must not be forgotten, that, in general, it must also pay, in part at least, for the scrapped machine. Only when a profit can be figured out on this basis, should the change be made. This profit need not be in the form of decreased cost of operation; it may be either improvement in the quality or increase in the quantity of the product.

Nor can it be assumed that the equipment of every new plant should be only of the best and latest. It is of little use to install

the most efficient machinery if it must be operated inefficiently. Taking as a basis of computation the cost of the cheapest equipment that will do the work satisfactorily, every additional expense for better machinery must be shown to be a profitable investment under the conditions in which it will be used.

The position, which should be taken by every engineer in behalf of his employers, is not antagonistic to the inventor. If the latter has a device which best fulfils the requirements of the case, it will be used. The inventor should recogniz the correctness of the principle and not expect the engineer or investor to throw out an old machine simply because the newer is a little better. The latter must be enough better to make the change profitable, and it is the inventor's business to prove this to the satisfaction of the man who is asked to buy.

ISOLATED PLANTS OR CENTRAL STATION POWER FOR FACTORIES.

While the electric drive brings great advantages in factories, it does not follow that it is always advisable for a factory to install its own generating plant. Factory operators, under the old system, have had control of their power supply, and probably hesitate somewhat before relying upon an outside source; but an examination of the problem would seem to show that, in many cases at least, it would be better to purchase power than to install and operate a plant at the factory.

One of the advantages—possibly the chief advantage—of purchasing power will be the greater reliability secured. A large station can be depended upon more surely for a continuous supply of electrical energy than can the most carefully operated isolated plant, for it spares no expense to secure reliability. It is well known that certain of our largest stations have not been without power in their mains for ten years or more. This is attained not only by careful design, but by the large size of the generating units installed, as well as that of the entire station.

Another important consideration which should have much weight with the operator is this, if he buys his power he has the care of his own plant removed from his shoulders, and therefore has more opportunity to improve the operation of his factory. It is by attention to details that the best performance is obtained, and it is not good policy to force a man who should put his entire thought upon the factory itself to be burdened with the cares of a power plant as well.

Other advantages which may be secured by purchasing power, rather than installing a plant at the factory, are these: the power available is not limited by a small equipment; the factory may be enlarged and additional motors installed practically at will, while in an isolated plant the available output of the latter always limits the growth of the factory until an increase can be made which will justify an addition to the generating plant.

Eliminating the isolated plant will often set free space which can be utilized for additions to the factory proper, or for other purposes. If a new factory is to be installed, the money which would otherwise be invested in the generating plant may be more profitably used to increase the size of the factory itself. Further, for a new factory there is freer choice of site when power is to be purchased than when it is to be generated.

As against these advantages, there may be the increase in the cost of power when purchased rather than generated. This may or may not be important. It is probable, in many cases, that power can be purchased more cheaply than it can be generated, and in making a comparison, the factory operator should be honest to himself, and charge against his generating plant everything which should properly be charged. The factory load is, in general, a desirable one for the central station, since it comes in the daytime, and overlaps the peaks of the station, if at all, for a few months only. For this reason advantageous rates can be secured from the central station. Even assuming the cost of power to be somewhat more, the cost of the power itself is only a small part of that of operating the factory, and the slight increase in this would, in many cases, be unimportant compared with the advantages which may be gained by purchasing power. The principal of these, as mentioned above, are increased reliability and concentration of effort. To secure the best results it is highly important to have no interference with the work of the factory, and therefore the factory should devote itself to doing its own work, and not to the secondary work of generating power.

A GOVERNMENT LIGHT AND POWER PLANT.

The Treasury Department has issued a pamphlet setting forth preliminary plans for a light, heat and power plant which it is proposed to install in Washington, D. C., for supplying certain government buildings. The estimates have been carefully made, and a number of alternative plans have been studied. Evidently a great deal of care has been devoted to preparing the report. The object of installing this plant is to reduce the expense of the government. It is said that a previous undertaking of a similar character, though of less magnitude, reduced the expense to the government by about $7,000 per year.

Assuming that the estimates given in this report are correct —and we have no means of checking them, and no disposition to doubt them—on the face of it the installation of such a plant would seem to be desirable; but there are other things to be considered. The government work at Washington is getting more and more cumbersome, and every undertaking of this character adds to the burden of the officials there. Such a plant would be taken care of by an engineer retained for that purpose. This man would be responsible to some one over him, and the duties of the latter would thereby be increased. This may be a small matter in this particular case, but if the government starts generating its own electricity, why should it not make its own gas or its own paper, or any of the thousand and one things which it to-day purchases? The principle involved is one of doubtful expediency, if looked at in this way; and is not this the proper way to look at it? If there were no other way of obtaining the necessary power, the situation would be different, but no such reason is given in the report. The argument for the plant is based simply on the saving of expense, and none of the larger problems involved is considered. The desirability of having the government enter into competition with private interests may be questioned. Although the situation at Washington is different from that elsewhere, the increasing tendency for the federal, state and municipal governments to enter into the business of supplying power for lighting buildings or operating railway systems, or other such businesses, even though they be more or less of a public nature, is one which, we believe, is greatly to be deplored.

ELECTRICAL METHODS OF MEASURING TEMPERATURE.

Exact methods are important in scientific research. They are highly desirable, as well, in industrial applications. This is being realized more and more every day, and no doubt the ease with which accurate electrical measurements are made has done much to bring this about.

Until recently, in furnace processes or all processes where high temperature were used, the manufacturer has been at a disadvantage, for there was no readily available method of measuring accurately such temperatures. It was usual to rely upon the judgment of an expert who had devoted years of his life to a particular process. Such experts doubtless acquired great skill, but there is always a possibility of error, which may cause a loss, and even disaster. In some industries methods have been used which indicate approximately the temperature within the furnace, but while acting as rough guides, such methods are far from satisfactory.

To-day there are available two simple and accurate methods of measuring temperatures, both depending upon electrical effects. In one the change in resistance of a wire with change in temperature is measured. In the other, the electromotive force set up in a thermoelectric couple is measured, and from this the temperature of the couple is determined. These measurements may be made with simple apparatus. They may be made at any time, and thus guide the operator in his work. Each of the two methods has some advantages which are worth noting.

The resistance method is possibly the more accurate of the two, since a greater effect is produced for a given change in temperature, and, further, the zero method of obtaining readings adds to the accuracy of the determination. A pyrometer of this description may have a high sensibility; it may be even more sensitive than the air thermometer, since the change in resistance for each degree change in temperature can be made to be greater than the corresponding change in the volume of air. The electrical resistance pyrometer is suitable for measuring temperatures of enclosures, since the indication is that of the average temperature of the wire. The device, however, is somewhat more complex than a thermoelectric pyrometer, because its construction must be such as to eliminate the errors due to change in the resistance of the wires connecting the instrument with the galvanometer. Pyrometers of this kind may be used for a long time without any change in their constants. They are easily calibrated when once the characteristic of the resistance wire is known, but it is well to note that the variation in resistance is not directly proportional to the change in temperature. In other words, the characteristic is curved, and not a straight line.

The thermoelectric pyrometer is a simpler device than the resistance pyrometer. It is less sensitive, but should be sufficiently accurate for almost any industrial purpose. It is particularly well adapted for determining the temperature at a point. Excellent pyrometers of both these types may now be obtained from instrument makers. If, however, this expense does not seem to be justified, a simple, but satisfactory, thermoelectric pyrometer is easily made. The usual materials used for the couple are platinum and platinum-rhodium, but other metals or alloys, though less sensitive, may be satisfactory for the purpose. Any type of galvanometer or low-potential reading instrument can be used and the apparatus is readily calibrated. There is no reason to-day for any laboratory being handicapped by the lack of a satisfactory pyrometer.

THE MYSTERY OF ELECTRICITY.

In a recent lecture before the New York Electrical Society, President H. H. Vreeland, of the New York City Railway Company, spoke, incidentally, of the peculiar feeling which the public has for anything electrical. Electricity is usually spoken of as the most mysterious force known, and this feeling is played upon by the unscrupulous, who, by attributing to electricity the virtues they claim for their wares, deceive many who would not give the article in question a moment's consideration if the word "electricity" were not connected with it. Now we know more about electrical energy than any other form—that is to say, we are able to produce it, control it, transmit it, and make it perform useful work with greater ease than we can any other form of energy. We know more about this branch of physics possibly than any other, and, in fact, the stupendous amount of energy which has been expended in electrical research during the last quarter of a century has extended our knowledge in practically all sciences. Yet in spite of this, electricity is considered mysterious. Now, is it not more mysterious to have ever present a force which we can not change, which acts we know not how, the effect of which we can not get away from, and which we can not direct? No one has explained why the apple falls, but we satisfy ourselves with the statement that it falls because the earth draws it to itself. But no one considers the force of gravity mysterious.

One explanation of this peculiar situation may lie in the newness of electrical phenomena. Gravity we have always had with us. So far as we know, the apple has always fallen when loosened from the tree, and that it continues to do so is not at all surprising. It is true we have had, since the beginning, electrical effects such as lightning and the action of charged bodies upon one another, but it is only recently that man has learned to control electrical energy and to do with it practically what he wills. As yet the newness of this new servant to man has not worn off. Things are done now which were thought impossible, if thought at all. Given electrical energy in a controllable form, to the man who does these things the method of doing them is simple, but the general public has not yet lost its feeling of awe for all things electrical.

Of course, it is true that no one can give any final explanation of how and why electrical energy acts, but is it not less mysterious to have a force directed along a wire, than to have one acting through space filled with we know not what?

India-Rubber in 1904.

The growing demand for india-rubber for use in manufacturing in the United States is illustrated by some figures just presented by the Department of Commerce and Labor through its bureau of statistics. They show that the value of india-rubber imported into the United States has grown from ten million dollars in 1884 to forty-four millions in 1904, and that the total value of india-rubber imports in the period 1884-1904 is, in round terms, about 440 millions of dollars. This increase in the value of rubber imported is due in part, however, to an advance in price, the average value per pound of the imports of crude rubber (including gutta-percha) having been in 1884 forty-three cents, and in 1904, seventy cents. The total quantity of rubber imported in a crude state in 1884 was 23,672,563 pounds, and in 1904, 61,889,758 pounds.

A comparison of the importations of rubber in 1904 with those of 1884 suggests not only the growing demand in the United States for this article, but the recognition of the importance of husbanding the rubber resources of the world. In 1884 the only rubber imports were crude rubber and gutta-percha. In 1904, however, there were not only crude rubber and gutta-percha, but also about fifteen million pounds of "gutta joolatong" or East Indian gum, a product of Borneo, which in certain lines of manufacture is utilized instead of india-rubber; and in addition to this sixteen million pounds of old and scrap rubber fit only for remanufacture. Thus it would appear that the rapidly growing demand for rubber and the consequent danger that it may in time exceed the supply are suggesting to the manufacturers and others engaged in this industry the importance of husbanding of resources as far as possible.

Brazil, of course, supplies the largest share of the rubber imports of the United States. Of the sixty-two million pounds of india-rubber imported in 1904, thirty-four and one-half million pounds came from Brazil, while the bulk of the remainder came, apparently, from Africa. The original sources, however, of the large rubber imports other than those from Brazil, are somewhat problematical, since twenty-two million pounds are reported by the bureau of statistics as imported from Europe; though as no European country produces india-rubber in any considerable quantities it must be assumed that it was brought by those European countries from some other part of the world, and that probably it originated in Africa and other of the colonies of the European countries. From the United Kingdom the imports of rubber have grown from six and one-half million pounds in the fiscal year 1893 to nine and three-quarter millions in 1903; from Germany, whose chief colonial possessions are in Africa, the imports of rubber have grown from one and one-half million pounds in 1893 to nearly three millions in 1903; from Belgium, whose colonial possessions are exclusively in Africa, the growth has been from thirty thousand pounds in 1893 to five millions in 1903; and from Portugal, whose chief colonial possessions are also in Africa, the imports have grown from one and one-half million pounds in 1893 to a little over two million pounds in 1903.

The Central American states also supply considerable quantities of rubber, the imports from Nicaragua being nearly one million pounds per annum, and the total from the other Central American states amounting to about 300 thousand pounds annually. From Mexico the quantity imported in 1904 amounted to 366,104 pounds, against 120,415 pounds in 1894. Colombia and Ecuador supply each about one-half million pounds annually, and the British East Indies about one-half million pounds.

The following table shows the quantity of india-rubber imported in each year, and the value of india-rubber, gutta-percha, and gutta joolatong imported annually from 1884 to 1904:

Calendar Year.	Imports of Crude India-Rubber. Pounds.	Imports of Crude India-Rubber, Gutta-Percha, and Gutta Joolatong. Dollars.
1884.....	*23,672,563	10,194,385
1885.....	*25,432,350	9,697,239
1886.....	*31,147,825	14,180,301
1887.....	*31,102,061	14,389,499
1888.....	*34,484,033	14,228,358
1889.....	*32,138,257	12,503,254
1890.....	34,353,417	16,719,604
1891.....	37,401,634	18,461,175
1892.....	37,469,715	18,921,432
1893.....	39,634,706	17,214,390
1894.....	35,370,889	16,187,738
1895.....	41,766,774	19,345,072
1896.....	34,059,909	15,779,726
1897.....	42,159,126	21,834,947
1898.....	44,236,070	26,069,128
1899.....	54,408,495	34,397,320
1900.....	49,337,183	28,720,165
1901.....	55,142,810	28,345,025
1902.....	50,865,902	25,516,269
1903.....	55,744,120	35,762,943
1904.....	61,889,758	44,477,230

*Includes gutta-percha.

The Annual Report of the Mackay Companies.

In the annual report to the shareholders of the Mackay Companies, issued Friday, February 24, Clarence H. Mackay, John I. Waterbury, T. Jefferson Coolidge, Jr., and William W. Cook, trustees, present facts and figures showing the various enterprises controlled by the organization to be in a flourishing condition, while plans are in progress which will further increase their prosperity.

"The Mackay Companies," says the report, "owns the entire capital stock of the Commercial Cable Company ($23,000,000), and also shares of the capital stock of other cable, telephone and telegraph companies in the United States, Canada and Europe. All of these are dividend paying.

"In addition it has $820,323.70 in cash and cash assets.

"It has no debts.

"Its authorized capital is $50,000,000 preferred shares and $50,000,000 common shares, of which there are outstanding $35,968,700 preferred shares and $41,380,400 common shares.

"Quarterly dividends have been regularly paid on the outstanding preferred shares and the first semi-annual dividend on the common shares was paid January 10, 1905.

"The Mackay Companies has, in connection with the increase of the capital stock of the Commercial Cable Company, paid to the Commercial Cable Company the entire cost of the fifth submarine cable to Europe, the laying of which is rendered necessary by the growth of the company's business and the rapid service demanded by the public. This fifth cable will be put in operation during the coming summer.

"The increase in the capital stock of the Commercial Cable Company has been made solely to the Mackay Companies and entirely for the benefit of the shareholders of the Mackay Companies. The Commercial Pacific Cable Company is completing arrangements for laying submarine cables to Japan from Guam, and to China from Manila. These two new cables will be put in operation during the present year. Transfer offices have been opened in Boston, Montreal and Toronto, and arrangements have been made for the establishment of a transfer office in New York city."

The following table of accounts is presented:

Profit and loss account for the period December 19, 1903, to February 23, 1905:

RECEIPTS.	
Dividends received from investments in other companies	$1,643,676.93
DISBURSEMENTS.	
Dividends paid to shareholders of the Mackay Companies	$1,559,843.23
General expenses, including rent, office expenses, engraving, trustees' compensation in full to date, etc	20,035.01
Balance carried forward	63,798.69
	$1,643,676.93
ASSETS.	
Investments in other companies, including the entire capital stock of the Commercial Cable Company ($23,000,000) and 14,692 shares in thirty other cable, telegraph and telephone companies	$76,602,574.99
Cash	340,338.70
Other cash assets	479,985.00
	$77,422,898.69
LIABILITIES.	
Preferred shares issued	$35,968,700.00
Common shares issued	41,390,400.00
Reserve for expenses	10,000.00
Balance, profit	63,798.69
	$77,422,898.69

EFFECT OF LOAD-FACTOR ON COST OF POWER.[1]

BY E. M. ARCHIBALD.

The great desideratum for an electrical system is a high load-factor with consequent greatest return on investment; load-factor being the ratio of average to maximum load. All the factors of expense included in cost of power to the consumer are then operating at maximum economy, and cost of power is at a minimum.

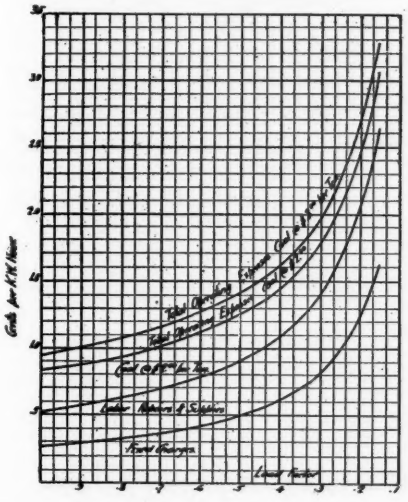


FIG. 1.—OPERATING EXPENSES OF 900-KILOWATT CONDENSING STEAM PLANT, PEAK LOAD, 750 KILOWATTS.

The lighting of residences and offices produces a peak in the late afternoon and evening, with but little load the remainder of the twenty-four hours; consequently the average load on the plant with lighting only is very small and the load-factor low. A commercial motor load in connection with lighting will increase the average load even though causing a greater peak. The addition of a street railway load still further increases the day load, but in consequence of the heavy demand load during the rush hours, when the public is going to and from business, which occurs at the peak of the lighting load, the peak load on the plant is greatly increased. This heavy peak, with but a small average load over the twenty-four hours, produces a low load-factor, and a portion of the machinery being shut down the greater part of the time, higher rates must be paid by the consumer to secure a certain return on first investment than when the load-factor is higher.

Evidently, when the load-factor is 100 per cent, that is when the load is constant throughout the twenty-four hours, and all the machinery is in continuous operation, the cost of power per kilowatt-hour is a minimum, and the greatest return on investment is realized. Customers having a steady load or with high average load are greatly desired and may be offered better rates than all others. It will be the endeavor of this paper to determine the decreased cost of power with increasing load-factor.

The storage battery is evidently a means in the hands of the power producing company of increasing the average load on the machinery. By charging the battery during light load and discharging during periods of heavy load, a more constant load on the generating apparatus is produced, with consequent better efficiency, and at the same time acting as a reserve in case of accident in the power plant. Unfortunately the battery is expensive, and a loss occurs in its operation which greatly reduces the higher efficiency secured by the increased load-factor. The great benefits obtained by its use are reserve capacity and voltage regulation, enabling the use of more efficient lamps.

The storage battery, however, has not been considered in what follows, even where it might be desirable, but rather a plant is assumed of certain maximum capacity for the peak load, and we are to determine what effect various load-factors have on the cost of power produced.

The various expenses involved in the cost of power to the consumer are as follows: (1) management; (2) distribution; (3) production.

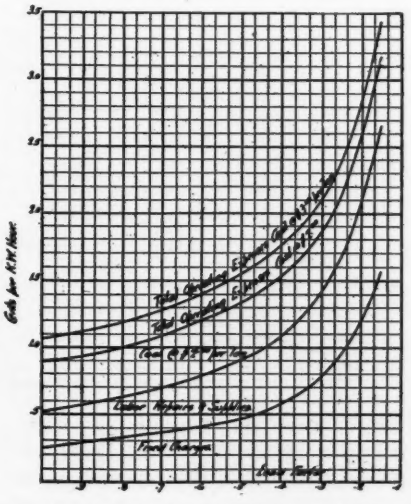


FIG. 2.—OPERATING EXPENSES OF 900-KILOWATT NON-CONDENSING STEAM PLANT, PEAK LOAD, 750 KILOWATTS.

For a given system with given peak load the cost of management is practically constant, no matter what the load-factor.

The cost of distribution is constant with various load-factors in so far as the fixed charges and maintenance are concerned. The losses in distribution, however, vary, these consisting of losses in lines, transformers if alternating current is used, meters, losses in grounds and losses from theft of current; all decrease the output and accordingly increase the cost to the consumer. While it is possible to determine fairly accurately the losses in lines, transformers and meters with varying load-factors, the losses from grounds and theft are indeterminate and require constant attention to keep them within certain limits. Yet as a rule these latter will become a smaller percentage of the total output the higher the load-factor.

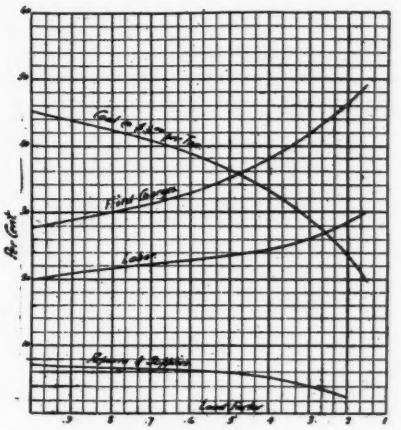


FIG. 3.—RATIO OF INDIVIDUAL ITEMS OF OPERATING EXPENSES TO TOTAL OPERATING EXPENSES, 900-KILOWATT CONDENSING STEAM PLANT, PEAK LOAD, 750 KILOWATTS.

There yet remains for consideration the effect of the load-factor on the actual cost of production of energy.

The higher the load-factor, the greater is the amount of power produced, the longer does the apparatus operate most efficiently, the lower the ratio of fixed charges to total operating expenses and consequently the lower the cost of power per unit.

To determine exactly in what proportion the cost of power is decreased, it will be necessary to assume a plant, determine the fixed and variable charges and thereby the cost per kilowatt-hour at various load-factors.

Let us take for example a plant with a peak load of 750 kilowatts. Allow three units of 300-kilowatt capacity each, so that in case of a breakdown to one, the other two may take care of the peak with an overload of twenty-five per cent on each and sufficient boiler capacity for the same contingency. No provision is allowed for stokers, coal-handling appa-

[1] Read at annual meeting of the Canadian Society of Civil Engineers, Montreal, January 24, 25, 26.

ratus or economizers; plant assumed to be on the water front providing sufficient water for condensing purposes.

Curves are also plotted for a second plant of the same capacity as the first, but operating non-condensing; in both cases either water or railroad connections

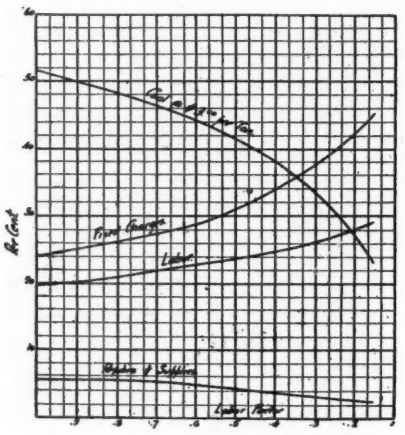


FIG. 4.—RATIO OF INDIVIDUAL ITEMS OF OPERATING EXPENSES TO TOTAL OPERATING EXPENSES, 900-KILOWATT NON-CONDENSING STEAM PLANT, PEAK LOAD, 750 KILOWATTS.

assumed with convenient facilities for coal-handling and removal of ashes.

First cost of plant complete:

Condensing, $118,425, equivalent to $131.60 per kilowatt.

Non-condensing, $114,625, equivalent to $127.40 per kilowatt.

Fixed Charges.	Condensing.	Non-Condensing.
Interest at five per cent	$5,921.25	$5,731.25
Taxes and insurance at two per cent.....	2,368.50	2,292.50
Depreciation machinery ten per cent.....	7,710.00	7,305.00
Building three per cent	1,122.00	1,134.00
Total	$17,121.75	$16,462.75

The above first cost being for 100 per cent load-factor, there will be a varying reduction due to the decreased boiler capacity required on lower load-factors. A point is reached below which it is not advisable to further decrease the boiler capacity as the peak load must be taken care of and sufficient reserve provided for accidents and repairs; this point being taken in this case at forty per cent load-factor. The effect of this reduction is to diminish the fixed charges at forty per cent load-factor by $1,000 per year, or about six per cent of the total. From these figures the lower line in Figs. 1 and 2 is plotted and indicates the effect of fixed charges on the cost of power.

The remaining items of expense are what are generally termed operating charges and are variable with load-factor. These consist of (1) labor, oil and waste, supplies, water and repairs; (2) fuel.

The cost of labor varies to a certain extent with load-factor, but a minimum number of men required to operate the plant is reached at about forty per cent load-factor, below which this item remains constant. The cost of oil and waste, supplies, water and repairs varies almost directly with load-factor as the greater number of hours per day that the machinery remains in service, the greater do these expenses become, and *vice versa*. The second line in Figs. 1 and 2 is for these charges reduced to the kilowatt-hour basis and is added to the fixed charges curve; the difference between the two curves, therefore, represents the cost of labor, oil and waste, supplies, water and repairs.

The cost of fuel, usually coal, per unit of power generated, varies with some power of the load-factor less than one, depending upon the number and efficiency of units employed both in the engine and boiler rooms, also upon the cost per ton of coal, its heating value, and upon the ability of the fireman to get the best results; it is of the utmost importance to watch this item carefully, as greater economy can be secured in the cost of coal per kilowatt-hour than in any other item of expense. The calorific value of the coal should be tested from time to time and compared with the number of pounds used per kilowatt-hour.

The coal considered is assumed to contain 12,000 British thermal units per

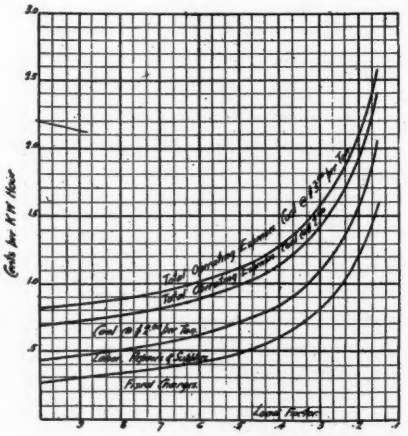


FIG. 5.—OPERATING EXPENSES OF 1,800-KILOWATT CONDENSING STEAM PLANT, PEAK LOAD, 1,500 KILOWATTS.

pound and two curves are plotted in Figs. 1 and 2 when the cost is $2 and $3 per ton respectively, the results being added to the two previous curves plotted. These figures of fuel cost per kilowatt-hour are above the average usually obtained and can only be secured by constant attention in the boiler room; for instance, at forty per cent load-factor in the first case one kilowatt-hour is generated from 3.5 pounds of coal from the pile.

The ratio of the individual items of expense to total operating expense is shown by Figs. 3 and 4 for the condensing and non-condensing plants respectively with coal at $3 per ton de-

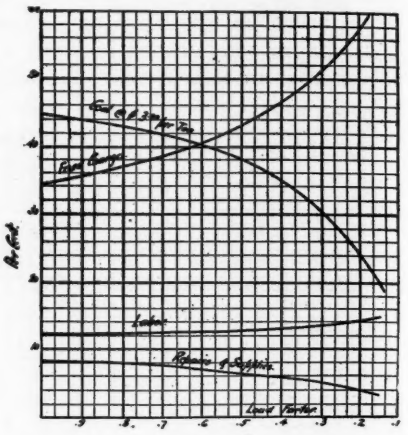


FIG. 6.—RATIO OF INDIVIDUAL ITEMS OF OPERATING EXPENSES TO TOTAL OPERATING EXPENSES, 1,800-KILOWATT CONDENSING STEAM PLANT, PEAK LOAD, 1,500 KILOWATTS.

livered. It is interesting in this connection to note the high percentage of fuel cost; in the average plant this percentage will be still higher than that shown, but this indicates how great a factor is the cost of fuel particularly with high load-factors. For low load-factor the fuel is subordinated by the fixed charges, which is by far the heaviest item.

Having thus determined the cost of power for a plant with a peak of 750 kilowatts, we shall consider briefly a larger plant and ascertain what extra economies may be secured. This plant we shall assume to have a peak load of 1,500 kilowatts and a maximum capacity of 1,800 kilowatts, divided into three units of 600 kilowatts each. Stokers are used, but no economizers or coal-handling apparatus; the boilers are in a single line parallel to the engine room, and coal is dumped from the car into a chute, whence it falls to the floor of the boiler room.

First cost of this plant at 100 per cent load-factor is $241,125, equivalent to $134 per kilowatt. Fixed charges, using the same per cent for interest, depreciation, taxes and insurance as in the previous case become $36,318.75 per year. Curves are plotted in Fig. 5 for fixed charges, labor, supplies and repairs, and fuel, the latter being plotted for the two prices $2 and $3 per ton as before.

With all these curves before us it might be well to make some deductions as to the advisability of further expenditures in

the power plant in coal-handling apparatus and economizers, or in general, any apparatus that tends to increase the economy.

The higher the load-factor the greater becomes the ratio of variable to fixed charges, and extra investment is advisable to secure the greatest economy possible. Extra investment in coal-handling apparatus and economizers will reduce the cost of labor and fuel in greater proportion than fixed charges are increased; the economizers also provide greater boiler capacity and purer feed water, reducing cost of repairs.

On the contrary when the load-factor on a system is low, the fixed charges are the governing factor in the cost of power, and extra expenditures must be carefully considered, particularly so if fuel is cheap.

Having thus discussed the effect of load-factor on the cost of producing power, we shall next turn to the cost of management and distribution. While it is beyond the scope of this paper to fully consider these costs, yet it was thought advisable to indicate by a curve, including all the various costs approximately, how the load-factor influences the cost to the consumer. This is done very generally, as no two cases are alike; the cost of distribution is more variable with different

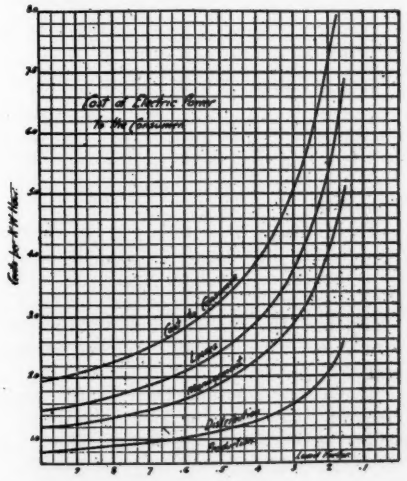


FIG. 7.—COST OF ELECTRIC POWER TO THE CONSUMER.

systems than is the cost of power, depending on the conditions of distribution, conduit or pole-line construction and the extent and density of the territory to be covered.

We shall allow that $50,000 per year covers all fixed charges, maintenance and attendance on the distributing network; $35,000 per year for management, dividends on stock and miscellaneous expenses. For total losses thirty per cent of the output is allowed; this is taken constant for all load-factors, for while the percentage of known losses varies directly with load-factor, the percentage of indeterminate losses by grounds and theft varies inversely as the load-factor. The actual losses from grounds are constant, hence percentage loss by grounds varies inversely as load-factor; losses from theft usually occur with customers having a short hour load, and the greater the amount of such load connected, the greater this loss. A customer having a long hour load runs a greater chance of detection than others. Hence, the above statement holds that the total percentage loss will be constant. Further, this lost power reduces the amount of sales, therefore affecting all the expenses included in cost to customer.

Fig. 7 shows a series of curves plotted for the 1,800-kilowatt steam plant, the lower line representing cost of production; the second, cost of distribution; third, cost of management, and fourth the effect of distribution losses on cost of power, this last being the final cost to consumer.

Coal is expensive, and from the nature of things will increase in price, and it behooves us to investigate any methods of producing power which are more economical in the use of fuel than the steam engine, and naturally turning to the gas engine we will next proceed to make a comparison between a steam plant and a gas plant generating producer gas for use in gas engines, and from such comparison deduce some general results.

As is well known the gas engine has a very much higher thermal efficiency than the steam engine, which fact, together with the fewer number of auxiliaries required, would naturally lead one to suppose that a greater economy could be secured in the production of power.

Difficulties, however, are encountered at the outset in the kind of fuel that may be used successfully in the gas producer. While the gas generated from anthracite coal is very successful in the operation of gas engines, the gas from bituminous coal contains tar, which, when carried through the valves into the cylinders of the engine, clogs the valves and carbonizes under the intense heat to which it is subjected in the cylinder, preventing successful operation. Some manufacturers claim to have succeeded in removing the tar or preventing its formation, but the burden of proof still rests with them.

The overload rating of the gas engine is different from the steam engine in the ratio of about fifteen to fifty per cent. Hence in designing two plants, steam and gas, for equal overload capacities, it is necessary either to use gas engines of twenty-five to thirty-five per cent higher normal rating, with consequent poorer economy at normal load; or add an extra engine and generator sufficient to take care of the extra overload capacity of the steam

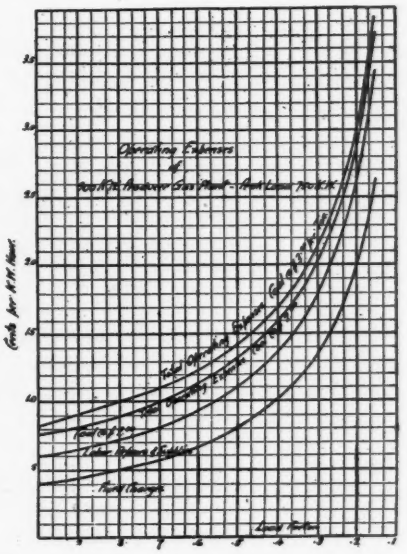


FIG. 8.—OPERATING EXPENSES OF 900-KILOWATT PRODUCER GAS PLANT, PEAK LOAD, 750 KILOWATTS.

engine over the gas engine. For example, in designing a gas plant of 900-kilowatt capacity with a peak load of 750 kilowatts, allowing the same reserve as in the steam plant considered previously, three engines of 530 brake horse-power each will be required with an aggregate normal brake horse-power of 1,590 and maximum brake horse-power of 1,830, as compared with three 450 indicated horse-power equivalent to 410 brake horse-power engines aggregating 1,230 normal brake horse-power and 1,840 maximum brake horse-power; or three gas engines of 410 brake horse-power each and an additional engine of 360 brake horse-power aggregating 1,830 brake horse-power on maximum load (from a practical standpoint, this additional engine would be made of the same capacity as the rest, the cost being the same). In the first case at normal load on the generators the engines are thirty per cent underloaded with consequent poor efficiency; in the second case the first cost will be greater, due to the extra generator and increased size of building required.

Allowing the same reserve capacity in producers, and with three 530 brake horse-power gas engines direct-connected

to 300-kilowatt generators running at 100 revolutions per minute, the first cost becomes $167,650, equivalent to $186 per kilowatt.

FIXED CHARGES.

Interest at five per cent on $167,650	$8,382.50
Depreciation on machinery ten per cent	13,340.00
Depreciation on buildings three per cent	1,005.00
Taxes and insurance two per cent	3,353.00
Total	$26,080.50

The storage capacity at 100 per cent load-factor is small, about 20,000 cubic feet, and is provided more for uniformity of gas than for storage. In case of accident to one producer, a second may be under way producing gas inside half an hour. The question of storage is important, particularly at small load-factors when storage may be provided for the peak and a constant load maintained on the producers. In a plant of this size where the number of producers actually required is not over two with a third for reserve, it is more advisable to use the same number of producers for all load-factors and a small amount of storage for uniformity of gas and sudden peaks. Further, the extra storage capacity required for small load-factors costs about the same as an extra producer.

The operating costs for oil, water, repairs and supplies have been taken practically the same as for steam, as there are insufficient reliable data at hand on this subject at the present time.

Cost of labor is somewhat cheaper—for the type of producers considered only one man is actually required.

In Fig. 8 are given curves for cost of power with varying load-factor for this 900-kilowatt gas plant.

A comparison of Figs. 1, 2 and 8 shows a greater economy for the gas plant at the higher load-factors, but poorer economy at low load-factors due to the influence of the heavy fixed charges.

The higher the cost of coal the greater is the economy of the gas over the steam plant at high load-factors.

It must be remembered that the fuel economy in the case of the steam plants is taken considerably higher than the average and can only be secured by constant and careful attention to all the details around a power plant; in the gas plant the fuel at fifty per cent load-factor is taken at 1.4 pounds coal per brake horse-power-hour, which is somewhat higher than the manufacturers will guarantee. No matter how the fuel costs may vary from those given in these curves, they are relatively of far greater importance when the load-factor is high than when it is low.

Condensers for High Vacuum.

At a recent meeting of the Leeds local section of the Institution of Electrical Engineers, of Great Britain, a paper was read by Mr. J. D. Baile, entitled "Condensing Arrangements in Central Stations." The paper was divided into two parts. The first described the various forms of condensing apparatus; the second gave results of tests made recently. These were quoted to support the author's contention that in all but exceptional cases it is not difficult to maintain a vacuum of not less than twenty-eight inches. Where the condensing arrangements are made properly, this may be done without the use of abnormal amounts of cooling water, of a moderate temperature.

It is desirable that the exhaust steam connections should be short and as direct as possible. Extra length of exhaust pipe does not materially affect the vacuum, provided the area of the pipe be ample and the joints thoroughly air-tight, but each bend involves loss. All valves should have full throughway, as any contraction is equivalent to reducing the area of passage at that point, and introduces friction. At some tests recently made at the Battersea Electricity Works, there was found to be a drop of vacuum from engine exhaust to condenser of one and one-half inches of mercury, of which eight-tenths of an inch was due to the non-return valve. The flanges of exhaust pipes should be faced across in the lathe. The author has found that woodite rings make an excellent joint. They are rather costly, but keep tight and are durable. A light and satisfactory exhaust pipe may be made of riveted sheet steel, a quarter to three-eighths of an inch thick, galvanized, and with flanges riveted on. All joints of the pipe itself or of the flanges to the pipe should be calked.

The tests included condensing apparatus of the Holuton colliery, the Neppsend works, the West Bromwich plant, and the Manchester plant. The Houlton plant consisted of an ejector condenser with a centrifugal circulating pump driven by an electric motor. The temperature of the cooling water was 67.6 degrees Fahrenheit. The vacuum at the condenser was 26.17 inches of mercury with the barometer at 30.05. The cooling water required was 68.75 pounds per pound of steam, the total power generated being 314.4 kilowatts. The power required to drive the pumps was 7.1 per cent of the total. The head against which the pump operated was 47.5 feet.

The Neppsend works use a surface condenser. There is a three-throw air-pump and a centrifugal motor-driven circulating pump. The condenser has 3,000 square feet of cooling surface. The temperature of the condensing water is 65.3 degrees Fahrenheit. A vacuum of 27.7 inches of mercury is maintained with the barometer at 29.9. The cooling water required is thirty pounds per pound of steam. The total power generated is 1,610 kilowatts. That required to drive the pumps is 2.3 per cent of the total. The circulating pump operates against a head of twenty feet.

At the West Bromwich station a surface condenser is used. The temperature of the feed water is fifty-one degrees Fahrenheit, and the vacuum maintained is 28.2 inches of mercury with the barometer at 29.8. Fifty pounds of cooling water are required for each pound of steam. The total power generated is 446 kilowatts, and 2.5 per cent of this is used for driving the pumps. The head against which the circulating pump operates is fifteen feet.

The Manchester station has a jet condenser with wet and dry air-pumps. The circulating pump is centrifugal, and is driven by a motor. The temperature of the cooling water is eighty-two degrees Fahrenheit, but a vacuum of 26.66 inches of mercury is maintained with the barometer at 29.5. The cooling water per pound of steam is fifty pounds, and 2.2 per cent of the total power is required to drive the pumps. The circulating pump operates against a head of forty feet. The total power generated is 1,822 kilowatts.

Tests made at Crown Point, Leeds, gave vacua varying from 29.1 inches to 28.4 inches, as the load varied from 110 to 265 kilowatts. The barometer was at 30.25, and the temperature of the injection water was forty-six degrees Fahrenheit.

Tests conducted at Darby gave vacua varying from 28.4 to 28.7 inches. The temperature of the injection water was about fifty-five degrees, and the barometer was at thirty. The load was 240 kilowatts.

It is thought that these results support the author's contention, that the maintenance of vacua of twenty-eight inches or more is neither impossible in practice, nor costly.

The Armour Institute of Technology has recently received a full line of samples of conduits from the Fibre Conduit Company, of Orangeburgh, N. Y. These samples, representing the various kinds of conduits used in telephone work, have been placed in the telephone laboratory of the institute.

The Largest Municipal Electric Plant in New England.

By Alton D. Adams.

TAUNTON, Mass., has the largest municipal electric plant in New England, and the commercial load is perhaps greater than that of any similar plant in the United States. Municipal plants sometimes continue to use antiquated apparatus and uneconomical methods of operation long after they ought to be abandoned, but Taunton has entirely discarded an old-style electric equipment that it bought several years ago, and has erected a new plant of the most modern sort.

Taunton river, which finds its way to open water through Narragansett bay, is navigable as far as the city of the same name, for fairly large craft, and its water is suitable for use in boilers as well as in condensers. On the bank of this river, at a point little more than a mile distant from the business centre of Taunton, the new electric plant of that city is located. At the old plant the ground area was too restricted, the supply of water from Mill river was unsuitable for boilers and insufficient for condensing, and the belt-driven apparatus was of the divers types common in stations designed fifteen years ago. Transportation to and from the old plant was possible only in carts.

With the new plant all this is changed. Coal barges come directly to the station. The river water is used for both steam and condensing purposes, the main generators are of a single type, direct-connected to their engines, and there is ample room for future extensions. With this change in the generating plant, the frequency on the alternating lines has been reduced from about 133 to 60 cycles per second; open direct-current arc lamps for street lighting have been replaced by enclosed arcs on constant-current alternating lines, and the greater part of the power load consists of induction motors. During the time when all of these changes were going on an increasing load had to be carried, so that the transfer from the old to the new plant was gradual, but the latter was started in September, 1903, and is now carrying the total load.

Boiler Equipment, Municipal Electric Light and Power Plant, Taunton, Mass.

The site of the new generating station fronts on the Taunton river with a wharf 250 feet long and eighty feet wide.

The new station is a one-story brick building, 46 feet high, 109 by 120 feet in ground area, and has a basement with a concrete floor, and a plank, tar and gravel roof on steel trusses. At one side of the boiler room there is a brick coal pocket 22 by 86 feet on the ground and 15 feet high, that takes coal through

hatchways at the top. Within the building a twenty-inch brick wall divides it into two nearly equal parts. One of these halves of the station contains the engines and electric equipment, and the other is divided into a space about 55 by 100 feet for the boiler room, and a space about 20 by 55 feet for offices and a testing room. This office portion is finished in two stories.

The engine foundations rise ten feet above the basement floor, and the floor of the generator room is level with the tops of these foundations. In the boiler room the floor level is nearly the same as that in the basement. At one side of the boiler room, but outside of it, is the round brick chimney, 154 feet high and with a flue ninety inches in diameter. This chimney will give sufficient draught for a boiler capacity of 2,000 horse-power. Three water-tube boilers of the Heine make and rated at 300 horse-power each are now in use, and there is enough space in the boiler room to more than double this capacity. Firing under these boilers is done by hand, and all three connect with a horizontal steel flue that runs to the chimney. Pipes pass from the boilers through the brick wall and into the engine room and basement, and are arranged in a very desirable way, as may be noted from the plans. Connected with the piping of each engine is a Bulkley siphon condenser.

At the present time two main generating units have been erected in the engine room which measures 50 by 100 feet, but there is ample space for a large increase of capacity in the station as now built. Each of these units is made up of a 400-kilowatt, 2,300-volt, sixty-cycle, two-phase alternator, direct-mounted between the high and low-pressure cylinders of a compound vertical engine. Each of these engines is rated at 625 horse-power minimum and 825 horse-power maximum, when run condensing, and they were made by the McIntosh & Seymour Company. The engines and their direct-connected generators operate at 150 revolutions per minute. In the same room with the main generators are two exciting dynamos, one driven by a direct-connected engine and the other by an induction motor. One exciter, driven by a General Electric upright engine at 450 revolutions per minute, is rated at 200 amperes and 125 volts. The other exciting dynamo is direct-connected to a fifty-horse-power, fourteen-ampere, 2,080-volt, sixty-cycle, two-phase induction motor that has a speed of 720 revolutions per minute, and this dynamo is rated at 280 amperes and 125 volts. On a line parallel with that of the main generators stands a marble switchboard of thirteen panels in a steel frame, twenty-four feet long and seven feet high. This board carries nine hand-lever oil switches for the main generators and the 2,300-volt distribution circuits, three recording watt-meters, and a full line of indicating instruments. In the basement beneath the engine room there are three constant-current transformers, each rated at thirty kilowatts, 2,200 volts and sixty cycles, primary, and at 6.6 amperes on the secondary side. All of the above-named electrical equipment, generators, exciters, motors, transformers and switchboard, was made by the General Electric Company. A hand-power crane of the Reading make spans the entire width of the engine room, and has a range equal to the length of the latter.

Two classes of distribution go from the new generating station just considered, the 2,300-volt, sixty-cycle, two-phase circuits, and the series lines from the constant-current transformers, for arc lighting on the streets. A part of the 2,300-volt circuits are employed for the general distribution of light and power, and the remainder go from the generating station to the substation near the business centre of Taunton. The substation equipment occupies the building formerly used as a generating station, and from this point 500-volt direct current for motors, constant direct current for commercial arc lamps, and 6.6-ampere alternating current for arc street lamps are distributed. A brick building two stories high and 48 by 105 feet in ground area houses the substation equipment. For the supply of direct-current motors a 550-volt, 112-ampere, bipolar dynamo is belt-driven by a seventy-five-horse-power, 2,080-volt, twenty-ampere, two-phase induction motor. A similar motor, rated at fifty horse-power, 2,080 volts and fourteen amperes, is direct-connected to a Brush arc dynamo that has a capacity of eighty-five nominal, 2,000-candle-power lamps. Current from this dynamo is used exclusively for the operation of commercial arc lamps. There are also in this substation six constant-current transformers, each rated at thirty kilowatts, 2,200 volts primary, and 6.6 amperes secondary. These transformers, together with those of the same type at the generating station, nine in all, are devoted to the operation of street lamps, both incandescent and enclosed arcs.

All electric supply in Taunton, which had a population of 31,036, in 1900, is drawn from the city plant, but this has no connection with the street-car system. During the last four years there has been a large increase of the electric service, and this is especially true of the two latest years when loads have been carried in part at first and then entirely at the new station. On November 30, 1900, some of the main data of electric distribution in Taunton were as follows:

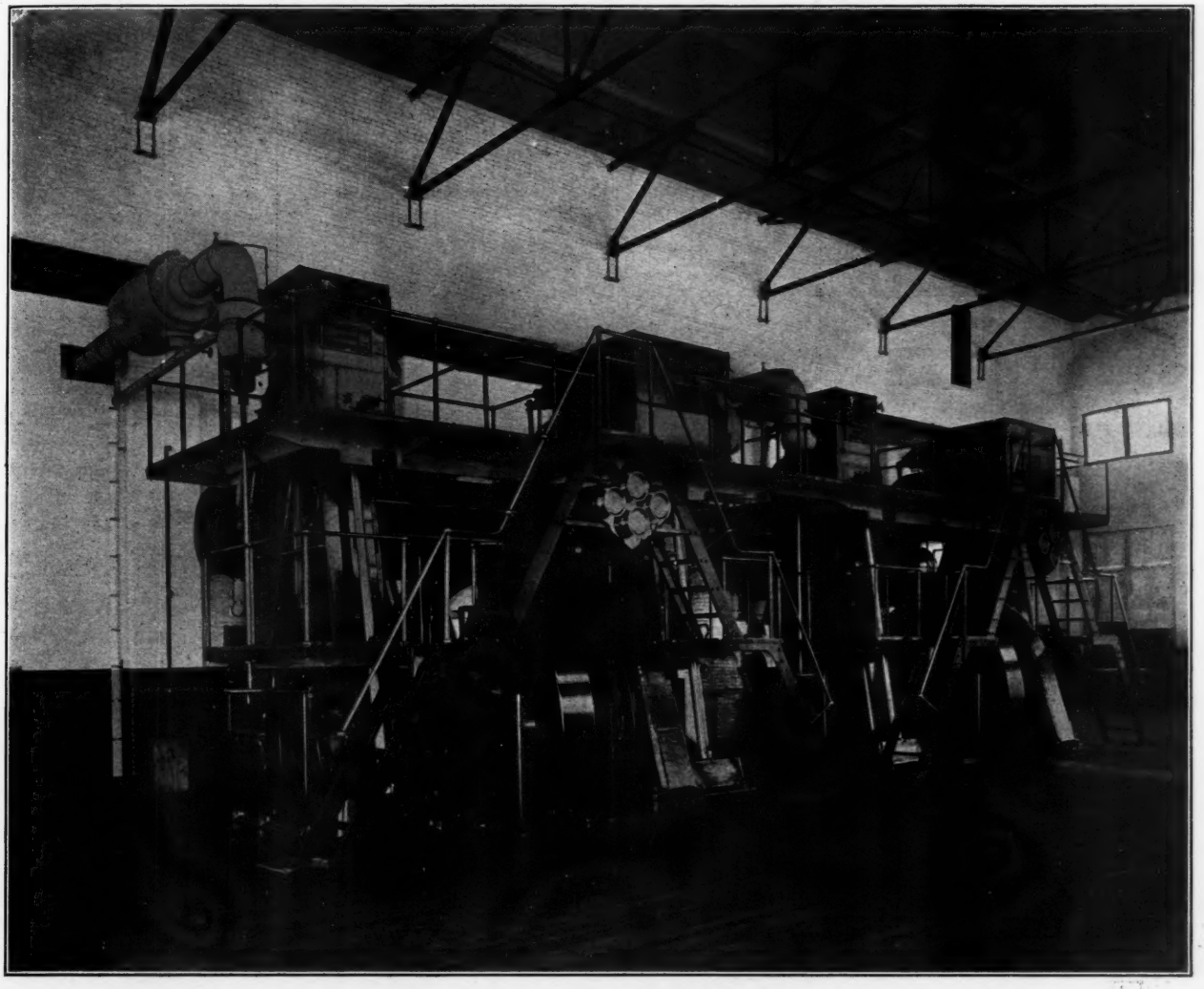
Number of commercial customers..	173
" incandescent lamps connected	6,558
" commercial arc lamps.	85
Total horse-power of motors.....	53
Number of meters in use.....	113
" transformers in use...	127
" arc street lamps.....	247
" tons of coal burned in year	1,898

In contrast with the above figures the conditions of electric supply on November 30, 1904, were as follows:

Number of commercial customers	264
" connected incandescent lamps.....	10,000
" commercial arc lamps	73
" meters in use.....	274
" arc street lamps.....	261
" incandescent street lamps	9
" transformers	153
Total horse-power of motors.....	530
Tons of coal used during year....	3,570
Average price per ton.....	$4.56
Number of poles in lines.....	1,166
Miles of line wire.....	91

The most notable items of increase in load during the four years in question are the incandescent lamps and motors. For the former the increase was fifty-two per cent, and the motor load was ten times as great in the latter as in the earlier year. Most of this motor load has come on during little more than one year, since the new station went into operation, on September 14, 1903. On November 30, 1902, the capacity of connected motors was only ninety horse-power, and it could have increased but little before the new station began to operate, because the rating of the power generator of the old plant was only eighty horse-power. During two years the motor load thus ran up from ninety to 530 horse-power. This rapid increase in power service is still going on, and at the present time the motor load of the electric system amounts to 738 horse-power, of which 110 horse-power is supplied with 500-volt, direct current, and 628 horse-power with two-phase, sixty-cycle current in induction motors. Among the users of electric motive power are a number of rather large manufacturing plants. One of these, a factory where printing-presses are made, uses motors of 250-horse-power rating besides the equivalent of 350 incandescent lamps. During the period in question the connected load of the electric system has been brought entirely onto a

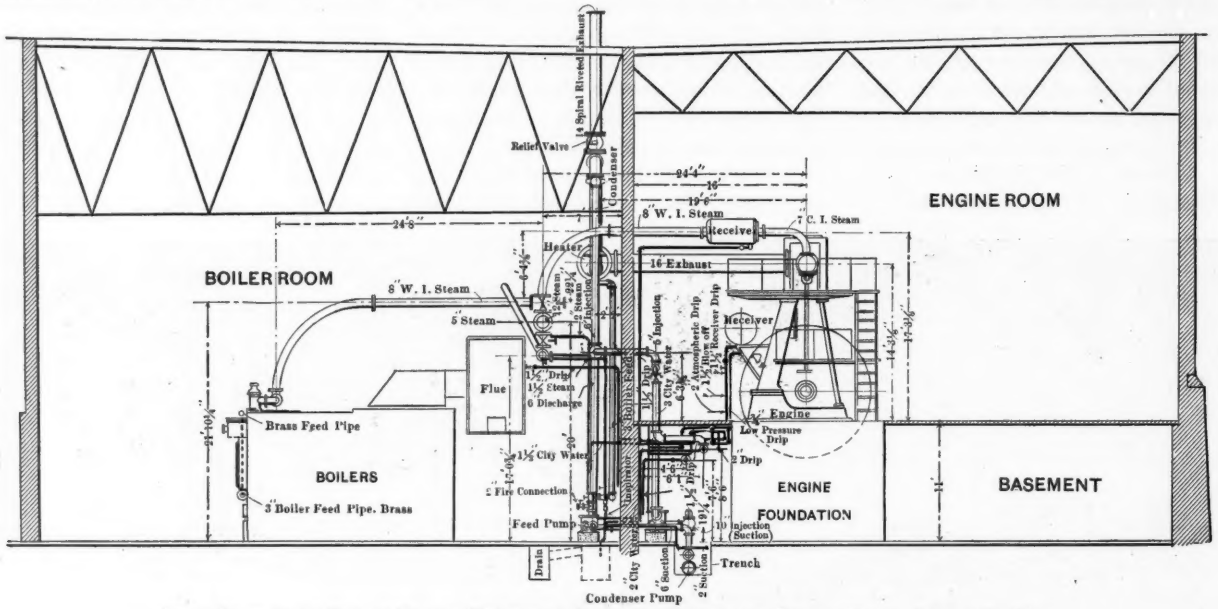
meter basis for commercial service, and the number of meters in use has increased from 113 to 274. It is to be noted that only 153 transformers were in use, in 1904, compared with 127, in 1900, in spite of the large increase of load. This is due to the fact that in the change from 133 to 60 cycles per second on the alternating lines large transformers were substituted for groups of smaller ones in many instances, so as to reduce core losses. Increase of the electric output is not measured by the rise in the number of commercial customers from 173, in 1900, to 264, in 1904, because many of the customers added to the system are factories and other large users of light or power. A better test of the rise in commercial business is found in the gross income derived from private consumers of electric light and power. During the year ending November 30, 1900, the total electric income from commercial service, both light and power, was $22,700.23, but for the year ending November 30, 1904, this income amounted to $37,514.53. Here again the important influence of the change from the old to the new generating plant is illustrated, for the year ending November 30, 1903, showed a gross electric income of $27,683.17 from private consumers, so that the fiscal year ending November 30, 1904, the first in which the new generating station operated during more than two months, showed a gain of thirty-five and one-half per cent in commercial income over the previous year. Of this gain, nine and one-half per cent represented the increase of income from commercial lighting, and 286 per cent the increase of income from power service. During the year ending November 30, 1900, the income from power service was only eight per cent of the entire commercial income, but for the year ending on the like date of 1904, the income from power service was twenty-eight per cent of the total paid by private consumers. For the operation of its 261 arc and nine incandescent street lamps the city of Taunton appropriated $9,166.65, in the fiscal year of 1904, so that on this basis the total income of the electric system from light and power service amounted to $46,681.18. These street lamps have been operated all night and every night since April 11, 1904. The new generating station, from which all electric supply is now drawn, operates twenty-four hours daily for commercial service. For the operation of the entire electric system the city employs seventeen men, as follows: a manager, one bookkeeper, one electrician, four dynamo tenders, one patrolman, a chief engineer, three assistant engineers, three firemen, one trimmer for arc lamps, and one lineman. During the fiscal year of 1904 there was paid to these men $16,923.13. This item does not include all the wages of persons engaged in special repairs at the station and on the lines.



Engine and Dynamo Equipment, Municipal Electric Light and Power Plant, Taunton, Mass.

Moderate prices for electric service and a scale of discounts to large consumers

have had much to do with the success of the Taunton plant in commercial business. Another important factor has been the general adoption of meter rates, and the uniformity of charges to all persons

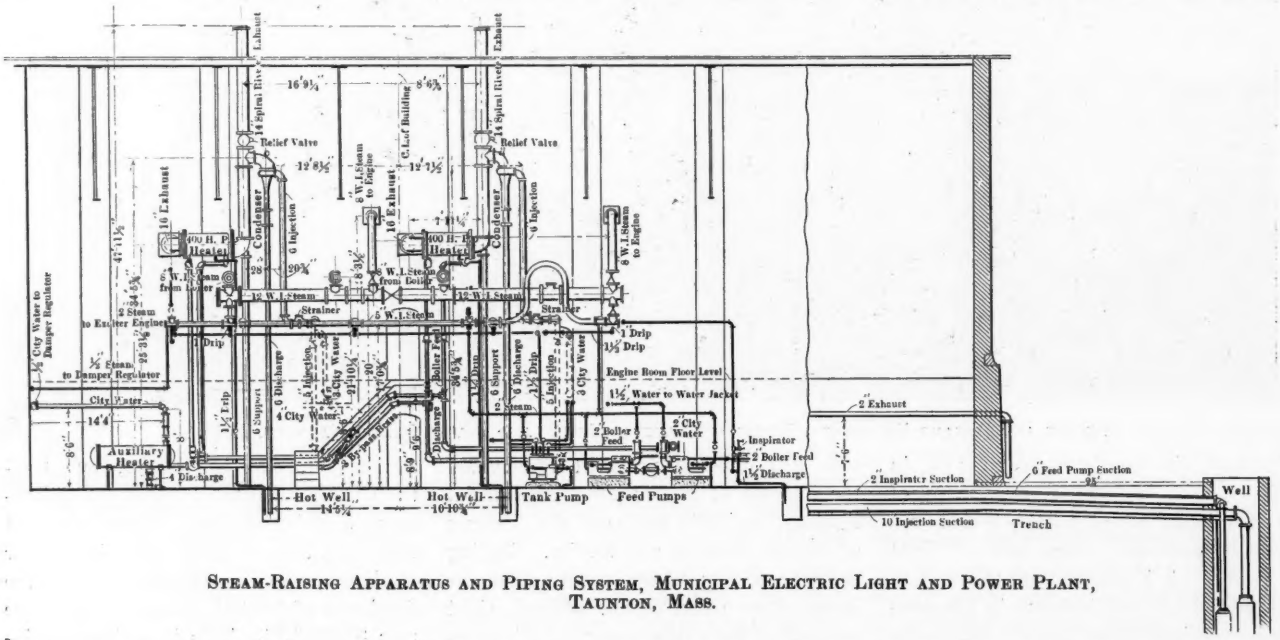


CROSS-SECTION OF POWER-HOUSE, MUNICIPAL ELECTRIC LIGHT AND POWER PLANT, TAUNTON, MASS.

that receive the same service. The full meter rate for incandescent lighting at Taunton is twenty cents per kilowatt-hour. If bills are paid by the twentieth of each month a discount of ten per cent on amounts between five and ten dollars, fifteen per cent between ten and fifteen dollars, twenty per cent between fifteen and twenty dollars, twenty-five per cent between twenty and thirty dollars, and thirty per cent between thirty and fifty dollars is allowed. On monthly bills of more than fifty dollars, discounts that range up to fifty per cent are granted, thus reducing the net price of energy for incandescent lighting to ten cents per kilowatt-hour. Incandescent lamps are renewed free. For power service the full rate is six cents per kilowatt-hour, and discounts reduce this to four cents for large consumers.

Besides the municipal electric plant, Taunton contains a coal gas plant that distributes gas of seventeen candle-power. This plant is owned by a private corporation that showed a gas income of $83,-884.81, with gas at $1.30 per 1,000 cubic feet, during the year ending June 30, 1903. As a result of its operations in that year, the latest for which the figures are available, the gas company showed an excess of $33,927.63 for earnings over expenses, and of this amount $12,800 was paid out in a dividend of eight per cent on the capital stock. It is interesting to note here that the electric plant has been owned and operated by the city since July 1, 1897.

As the new generating station is more than a mile from the old one, a large amount of line construction and change was necessary to connect the loads with the latter. In order to make these changes and give constant service both stations were operated during several months. One series circuit at a time was



STEAM-RAISING APPARATUS AND PIPING SYSTEM, MUNICIPAL ELECTRIC LIGHT AND POWER PLANT, TAUNTON, MASS.

equipped with enclosed alternating instead of open arc lamps, and was then disconnected from the old and connected with the new plant in a single day. In like manner, each of the 2,200-volt circuits for commercial lighting had its transformers of 133 cycles changed for those of sixty cycles, and its connections broken at the old plant and made at the new between daylight and dark of a single day. While this transfer of loads was going on neither the street lighting nor the commercial service was interrupted for a single day.

For the construction and equipment of the new generating station, the reconstruction of the distribution lines, and the purchase of new meters, arc lamps and transformers, the city of Taunton issued its bonds to the amount of $175,000, bearing interest at three and one-half per cent, in 1902, and these bonds were sold at par. The real estate on which the new station is located, which is ample for a far greater generating capacity than the present one, all improvements on this real estate including the wharf, coal pocket and station building, together with the complete steam power and electric equipment of 800 kilowatts capacity, as above described, cost a little less than $140,000, or about $175 per kilowatt of capacity in main generators. Nearly all of the $35,000 remaining from the bond sale was expended for some of the apparatus named at the substation, so that the total cost of the changes in lines and equipment, and of the new power plant complete has been within the $175,000 estimated and appropriated for the purpose. In the matter of insurance the city follows a conservative policy. On the generating station a fire policy of $25,000 and a policy of $35,000 against boiler accidents are carried. There is also an employers' liability policy of $10,000.

At the old station, now used only as a substation, the steam-power plant includes one engine of sixty-five, one of 300, and one of 400-horse-power rating, three return tubular boilers of 150-horse-power capacity each, and a full equipment of pumps, heaters and condensers. Besides the eighty-horse-power, 500-volt generator, and the eighty-five-lamp arc dynamo, now operated by induction motors, the old station contains two alternators of 120-kilowatt and one of thirty-five-kilowatt capacity, and five forty-five-lamp and one 120-lamp arc dynamos. From this it may be seen that the generating capacity of the new station, with its 1,250 horse-power in steam engines and 800 kilowatts in main generators, is nearly twice that of the old. All of the generating equipment at the old station, save the two motor-driven dynamos, is to be dismantled and sold.

Success of the municipal electric plant in Taunton is due in a large degree to the efforts of Mr. Abner Coleman, its manager. Since Mr. Coleman undertook the management of the plant, in the fiscal year of 1901, the old system of flat rates has been replaced by charges on a meter basis. Rates for light and power have been reduced, and a sliding scale of charges according to the amount of energy used per month has been introduced. Two-phase current at sixty cycles has displaced that of single phase and 133 cycles per second, thus making the distribution of power on a large scale to induction motors practicable. Enclosed arcs have replaced the old double-carbon street lamps. Last, and most important, a modern generating plant of the most approved type and location has been put into operation instead of the ancient equipment formerly in use. The plans for this new plant were made by Mr. Coleman while engaged in his regular duties as manager.

The Annual Report of the Cuyahoga Telephone Company.

The annual report of the Cuyahoga Telephone Company, Cleveland, Ohio, shows that the company has had the most successful year in its history. The total assets are now $5,753,684.47, and the total liabilities, $5,727,292.32. During the past year the gross earnings of the company were $435,274.02, compared with $396,490.20 in 1903. The expenses for the past year were $220,748.79, against $194,191.90 for the preceding year. The net earnings for the year were $196,532.65, a gain of over $13,000 as compared with the preceding year. The surplus is $26,392.15, compared with $15,401.09 a year ago. The company has elaborate plans for extension during 1905, and contemplates expending nearly $850,000 for this purpose. It also proposes to increase the number of telephones by at least 6,000. In March, 1904, when the new switchboard of the company was cut in, the number of subscribers was 10,260. In January, 1905, the number was 14,370.

At the annual meeting, the following board of directors was chosen: W. H. Lamprecht, Henry Everett, R. A. Harman, Calvary Morris, E. W. Moore, C. W. Wason, F. M. Stearns, H. R. Newcomb, F. S. Dickson, P. H. McIntosh and C. A. Otis, Jr.

Faraday Society.

The eleventh ordinary meeting of the Faraday Society was held on Monday, January 30, 1905, at the Institution of Electrical Engineers, London, England, Professor A. K. Huntington being in the chair.

Mr. John G. A. Rhodin read a paper entitled, "Mass Analysis of Muntz's Metal by Electrolysis, and Some Notes on the Electrolytic Properties of This Alloy." The reading of the paper was accompanied by experiments.

The first portion of the paper describes an apparatus which was specially designed by the author for the purpose of the accurate and rapid determination of the copper content (which should lie between 60.5 and 61.5 per cent) of Muntz's metal. As about forty to sixty "heats" of metal are cast every day, and it being necessary to obtain the results within twelve hours of the time of casting, the apparatus had to be such as to enable 100 analyses to be made in twenty-four hours—with a mean probable error of not more than ± 0.1 per cent. The author decided that an electrolytic method would best fit in with these stringent requirements.

The electrodes employed consist of concentric cylinders of very fine platinum gauze, supported by stout frameworks in order to ensure even current distribution. The anode rests on a ring at the bottom of the containing-vessel, so that the cathode can easily be slipped away and removed, and both electrodes are held in modified Classen stands. The present installation consists of thirty such unit cells, and current is supplied to them from six pairs of accumulators, each of which supplies current to five pairs of electrodes, through suitable nickelin resistances.

One gramme of the alloy, dissolved in nitric acid, is used for analysis, and a current either of 0.5 ampere or else of two amperes is employed for the deposition. In the former case deposition is complete in twelve to fifteen hours, in the latter in three hours. Electrolysis proceeds in three phases: (1) copper deposition and ammoniacal reduction of nitric acid. (2) Ammoniacal reduction only. (3) Deposition of zinc. A perfect separation takes place if phase (2) occupies a long time and is unaccompanied by metal deposition. If certain impurities, such as arsenic or nickel, be present they must be removed chemically. The paper describes in detail the actual procedure at the works laboratory, and also includes a table showing the kind of accuracy obtained in cases where re-

analyses have been made. Since these analyses in bulk have been made it has been found that they act as an infallible guide to the casters, so that remelting has now become very rarely necessary.

In conclusion, the author discusses the electrochemical properties of Muntz's metal. The metal is largely used as a sheathing to protect ships' bottoms from certain mollusca and algæ, and to be successful it should dissolve in sea-water just to a sufficient extent as to render the surface poisonous, the best conditions being the equal dissolution of the copper and zinc. The author shows how these may be calculated approximately by supposing that the electrolytic dissolution rate is proportional to the heat of formation of the ultimate compounds (zinc and cuprous chlorides), and to the conductivities of the metals which dissolve. Assuming that both the chlorides of copper are formed, and taking the mean of the results in the two cases, the best values are found to be 60.811 per cent of copper, and 39.189 per cent of zinc, numbers which agree very closely with the results of practical experience. The author is now engaged in exhaustively investigating the absolute dissolution-velocity of pure Muntz's metal at a definite temperature, and he adds here a preliminary description of these experiments, describing in an appendix his most recent experiments on the subject. He finds that a binary alloy like Muntz's metal dissolves slowly at first, the velocity then quickly arrives at a maximum, then it falls suddenly—remaining almost constant for some time—and finally a more or less rapid fall again occurs. During the period of constant velocity the surface must alter as the resistance capacity, if the action is galvanic. The seat of electromotive force must be in the electrolyte, as the constancy of action indicates a steady electromotive force of considerable magnitude. It is probable that the result is influenced by the actual mass of metal present, relative to that of the solvent. The external pressure certainly exercises a very considerable effect on the reaction-velocity, by influencing the speed with which hydrogen can leave the surface of the metal.

Professor Huntington asked whether the author had considered the question of the best composition of Muntz's metal from the point of view of the constituents of the alloy, and of the critical points of the various combinations formed. He drew attention to the work of Mr. E. S. Shepherd on this subject, and showed the curves he had obtained in his study of the copper-zinc series. What determined whether the alloy would roll hot or not, appeared to be the presence of the compound Cu_2Zn.

Mr. W. R. Cooper thought there was some difficulty in the view that the dissolving action referred to by Mr. Rhodin was galvanic. If that were the case, he did not see how both metals could be affected.

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A transition temperature of fifty-nine degrees centigrade was obtained for the system $MgSO_4 \cdot 7H_2O + MgSO_4 \cdot Na_2SO_4 \cdot 4H_2O$, but it was found that only the double salt loeweit, $Na_4Mg_2(SO_4)_4\,5H_2O$, was formed, the usual transition-point (seventy-one degrees) being depressed to fifty-nine degrees centigrade by saturation with $MgSO_4$.

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TWO-MOTOR VERSUS FOUR-MOTOR EQUIPMENTS.[1]

BY N. McD. CRAWFORD.

It is manifestly impossible to consider judiciously the relative commercial efficiency of two-motor *versus* four-motor equipments, or to reach any absolute conclusion unless certain conditions under which the equipments are to be operated have first been determined. For the purpose of this paper a line was selected having light grades and reasonably small line losses, a line passing through the business centre of a city and reaching the residential section, thus at all hours of the day calling for a fair average number of stops and therefore reasonably rapid acceleration, in order to make the time schedule.

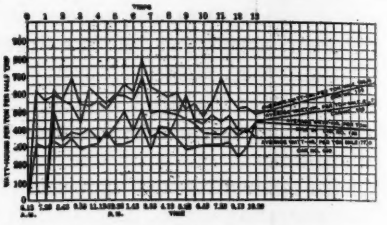

FIG. 1.—AVERAGE WATT-HOURS PER TON-MILE.

Four types of equipment were selected for this service, as follows: car 169 having a twenty-foot body, single trucks, two twenty-five-horse-power motors, and a gear ratio of 1 to 4.87; car 138, having a twenty-six-foot body, two trucks, two thirty-five-horse-power motors, and a gear ratio of 1 to 2.82; car 101, having the same length of body and number of trucks as car 138, but having four thirty-five-horse-power motors and a gear ratio

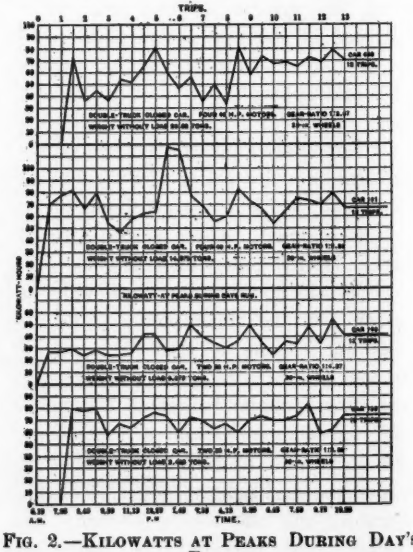

FIG. 2.—KILOWATTS AT PEAKS DURING DAY'S RUN.

[1] A paper presented at the 194th meeting of the American Institute of Electrical Engineers, New York, February 24, 1905.

of 1 to 2.82; car 480, having a twenty-nine-foot body, two trucks, four forty-horse-power motors, and a gear ratio of 1 to 3.67.

The service required of these four equipments was exactly the same, namely, 136.5 miles per day at an average schedule of 8.45 miles per hour. The runs were made on succeeding speed days and during the same relative hours. Each car

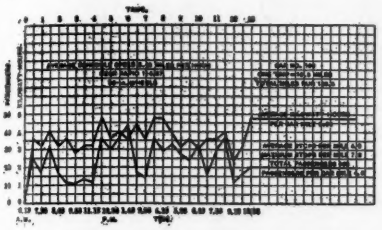

FIG. 3.—PASSENGERS AND KILOWATT-HOURS PER HALF TRIP.

was equipped with a wattmeter, an ammeter, and a voltmeter; the wattmeter readings at the end of each trip were recorded, and at the end of the run checked by the ammeter and voltmeter readings. The wattmeter was also carefully calibrated with a standard meter, using a water rheostat as a load. The peaks were noted at times of acceleration and on grades. These tests have been tabulated as follows:

Fig. 1, the average watt-hours per ton-mile.

Fig. 2, kilowatts at peaks during day's run.

Fig. 3, passengers and kilowatt-hours per half trip.

Fig. 4, passengers and kilowatt-hours per half trip.

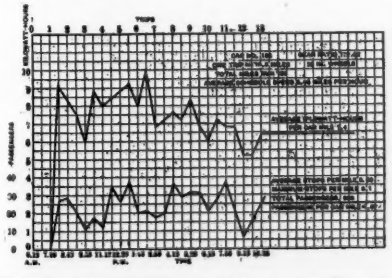

FIG. 4.—PASSENGERS AND KILOWATT-HOURS PER HALF TRIP.

Fig. 5, passengers and kilowatt-hours per half trip.

Fig. 6, passengers and kilowatt-hours per half trip.

Table i has been deduced from the sheets given.

The commercial efficiency E was obtained as follows: $A + B + C + D = E$, and $\frac{H}{E}$ = commercial efficiency.

The same formula, substituting B for H, will give greatest commercial efficiency. The letters used in the above formula represent the following:

A, cost of current per watt-hour at station switchboard.

B, value of seated load.

C, platform labor per mile run.

D, interest and depreciation per mile run, figured at eight per cent.

H, value of actual passengers carried per mile.

In obtaining the commercial efficiency, line losses and repairs of equipments and track have purposely been omitted, because it is almost impossible to determine what these values should be; the value of the standing load has been omitted for the same reason.

Applying the above formula and substituting values obtained during the test, the results are as follows:

CAR NO. 169.

$$0.0006787+1.30+0.0475+0.0043 = 1.3525$$

$$\frac{0.23}{1.3525} = 0.1698\%$$

$$0.0006787+1.30+0.0475+0.0043 = 1.3525$$

$$\frac{1.30}{1.3525} = 0.96\%$$

CAR NO. 138.

$$0.001056+1.70+0.0475+0.0056 = 1.7542$$

$$\frac{0.23}{1.7542} = 0.1310\%$$

$$0.001056+1.70+0.0475+0.0056 = 1.7542$$

$$\frac{1.70}{1.7542} = 0.96\%$$

CAR NO. 101.

$$0.001174+1.70+0.0475+0.0070 = 1.7557$$

$$\frac{0.22}{1.7557} = 0.1253\%$$

$$0.001174+1.70+0.0475+0.0070 = 1.7557$$

$$\frac{1.70}{1.7557} = 0.97\%$$

CAR NO. 480.

$$0.000847+2.10+0.0475+0.0087 = 2.1570$$

$$\frac{0.23}{2.1570} = 0.1065\%$$

$$0.000847+2.10+0.0475+0.0087 = 2.1570$$

$$\frac{2.10}{2.1570} = 0.97\%$$

TABLE I.

Car No.	Capacity, Seats.	Horse-Power Motors.	Gear-Ratio.	Total Tons.	Total Cost.	Cost per Seat.	Cost per Ton.	Commercial Efficiency, Per Cent.
169	26	two 25	1:4.87	9.075	$2,710	$104.23	$298.62	17.0
138	34	two 35	1:2.82	12.425	3,275	96 38	263.59	13.11
101	34	four 35	1:2.82	14 675	4,360	128 23	297.10	12.53
480	42	four 40	1:3.67	20.680	5,040	120.00	243.71	10.66

An examination of table i, readily shows that car 169 is the most efficient for the service selected. This apparent efficiency must, however, be modified when the number of passengers carried, as shown in Fig. 3, is considered, because it will be seen that many times during

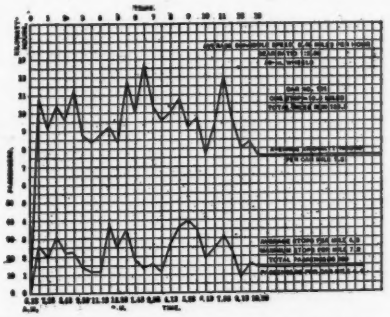

FIG. 5.—PASSENGERS AND KILOWATT-HOURS PER HALF TRIP.

the day's run the number of passengers was greater than twenty-six, the excess constituting a standing load.

Car 138, although showing a lower commercial efficiency, probably on account of its greater weight, yet accommodates the passengers much better throughout the entire day.

Car 480 was the least efficient of those tried, although there was only a short time when all the passengers could not be seated. This car was provided with thirty-three-inch wheels and could have

analyses have been made. Since these analyses in bulk have been made it has been found that they act as an infallible guide to the casters, so that remelting has now become very rarely necessary.

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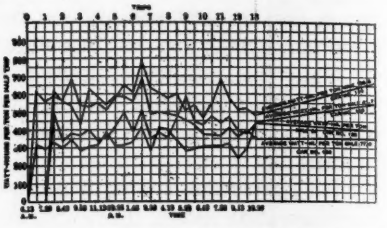

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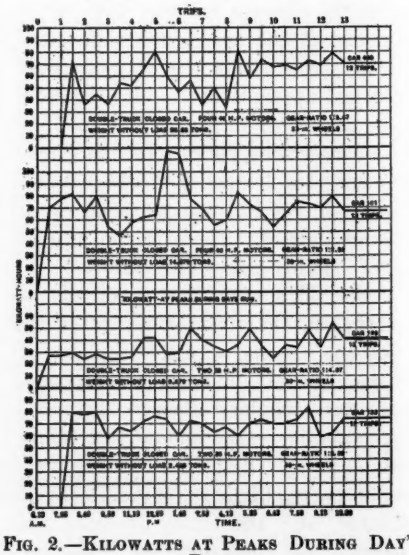

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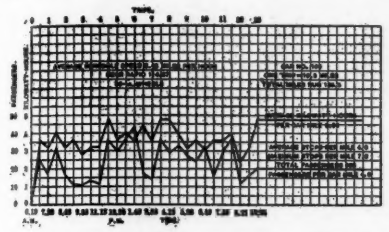

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Fig. 3, passengers and kilowatt-hours per half trip.

Fig. 4, passengers and kilowatt-hours per half trip.

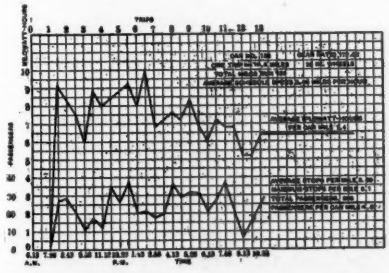


FIG. 4.—PASSENGERS AND KILOWATT-HOURS PER HALF TRIP.

Fig. 5, passengers and kilowatt-hours per half trip.

Fig. 6, passengers and kilowatt-hours per half trip.

Table i has been deduced from the sheets given.

The commercial efficiency E was obtained as follows: $A+B+C+D=E$, and $\frac{H}{E}$ = commercial efficiency.

The same formula, substituting B for H, will give greatest commercial efficiency. The letters used in the above formula represent the following:

A, cost of current per watt-hour at station switchboard.

B, value of seated load.

C, platform labor per mile run.

D, interest and depreciation per mile run, figured at eight per cent.

H, value of actual passengers carried per mile.

In obtaining the commercial efficiency, line losses and repairs of equipments and track have purposely been omitted, because it is almost impossible to determine what these values should be; the value of the standing load has been omitted for the same reason.

Applying the above formula and substituting values obtained during the test, the results are as follows:

CAR NO. 169.

$$0.0006787+1.30+0.0475+0.0043 = 1.3525$$

$$\frac{0.23}{1.3525} = 0.1698\%$$

$$0.0006787+1.30+0.0475+0.0043 = 1.3525$$

$$\frac{1.30}{1.3525} = 0.96\%$$

CAR NO. 138.

$$0.001056+1.70+0.0475+0.0056 = 1.7542$$

$$\frac{0.23}{1.7542} = 0.1310\%$$

$$0.001056+1.70+0.0475+0.0056 = 1.7542$$

$$\frac{1.70}{1.7542} = 0.96\%$$

CAR NO. 101.

$$0.001174+1.70+0.0475+0.0070 = 1.7557$$

$$\frac{0.22}{1.7557} = 0.1253\%$$

$$0.001174+1.70+0.0475+0.0070 = 1.7557$$

$$\frac{1.70}{1.7557} = 0.97\%$$

CAR NO. 480.

$$0.000847+2.10+0.0475+0.0087 = 2.1570$$

$$\frac{0.23}{2.1570} = 0.1065\%$$

$$0.000847+2.10+0.0475+0.0087 = 2.1570$$

$$\frac{2.10}{2.1570} = 0.97\%$$

TABLE I.

Car No.	Capacity, Seats.	Horse-Power Motors.	Gear-Ratio.	Total Tons.	Total Cost.	Cost per Seat.	Cost per Ton.	Commercial Efficiency, Per Cent.
169	26	two 25	1:4.87	9.075	$2,710	$104.23	$298.62	17.0
138	34	two 35	1:2.82	12.425	3,275	96 38	263.59	13.11
101	34	four 35	1:2.82	14 675	4,360	128 23	297.10	12.53
480	42	four 40	1:3.67	20.680	5,040	120.00	243.71	10.66

An examination of table i, readily shows that car 169 is the most efficient for the service selected. This apparent efficiency must, however, be modified when the number of passengers carried, as shown in Fig. 3, is considered, because it will be seen that many times during

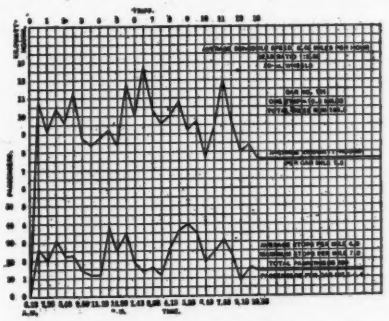


FIG. 5.—PASSENGERS AND KILOWATT-HOURS PER HALF TRIP.

the day's run the number of passengers was greater than twenty-six, the excess constituting a standing load.

Car 138, although showing a lower commercial efficiency, probably on account of its greater weight, yet accommodates the passengers much better throughout the entire day.

Car 480 was the least efficient of those tried, although there was only a short time when all the passengers could not be seated. This car was provided with thirty-three-inch wheels and could have

made the time schedule easily with a lower gear ratio.

Temperatures were taken at the end of each day's run; these were not excessive except possibly in the case of car 138, due no doubt to the weight of the equipment and the greater number of stops to the mile as shown on Fig. 4. (See appendix for record of temperatures.)

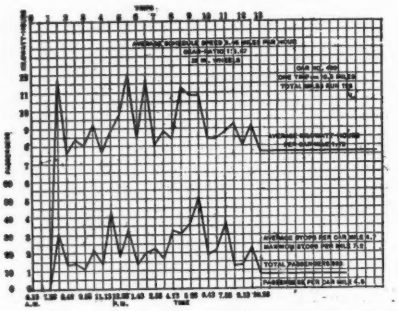


FIG. 6.—PASSENGERS AND KILOWATT-HOURS PER HALF TRIP.

The tabulated records point to the superiority of the light two-motor, single-truck equipments for service on the line and under the conditions selected. With longer trips, heavier grades, greater speed in miles per hour, and greater density of population, requiring more rapid acceleration, there is no doubt but that a car of the 480 type would show the greatest efficiency.

The operating manager is looking not only for an equipment that will fulfil all the requirements of any particular service with the least cost for repairs, and the minimum demand on the power station, but also for one that will combine these advantages at the greatest speed with safety to the public, and the distance to be traveled per trip will allow. If the distance is, say, six miles per half trip, or twelve miles per round trip, requiring four cars for fifteen-minute service at twelve miles per hour, and three cars for the same headway at sixteen miles per hour, the platform labor per mile in the first instance will be $0.0335 \times 4 = 0.1340$, and in the second instance $0.025 \times 3 = 0.075$, a saving in labor

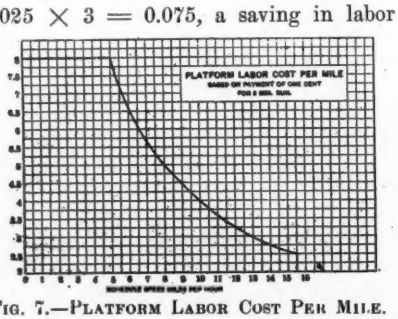


FIG. 7.—PLATFORM LABOR COST PER MILE.

of 0.059 per mile, and 0.0085 per car-mile. This great saving in cost of operation appeals to the operator, but not so greatly if the operating costs are increased by excessive demand on power-station equipment and by added interest charges due to increased line copper and rail bonds. In selecting motors and cars for a given run, it will be found necessary to consider the following:

Density of population, as governing the size and seating capacity of the car body; the number of stops per mile, and consequently the acceleration; the frequency of service; and the speed in miles per hour.

TABLE "I."

	1899	1900	1901	1902	1903	1904
Passenger-car miles, per cent increase	0.07	0.082	0.171	—0.0122	0.0247	0.051
Total passengers, per cent increase	0.06	0.021	0.0772	0.031	0.052	0.065
Passengers per car-mile, per cent increase	—0.009	0.058	—0.112	0.0375	0.0154	0 035
Kilowatt-hours at switchboard, per cent inc.	0.012	0.051	0.222	0.094	0.081	0.146
Kilowatt-hours per car-mile. per cent inc.	0.038	0.028	0.0462	0.105	0.085	0.06
Total miles of track, per cent increase	0.016	0.096	0.0408	0.0	0.0142	0.0153
Number regular cars operated, per cent inc.	0.0	0.167	0.058	0.081	0.0125	0.037
Schedule speed, per cent increase	—0.021	0.142	0.0058	0.0	0.0116	0.0

TABLE "J."

	1904	1903	1902	1901	1900	1899	1898
Passenger-car miles	4,420,873	4,206,435	4,104,488	4,155,414	3,546,564	3,278,314	3,063,705
Total passengers	17,726,397	16,735,071	15,900,325	15,434,068	14,319,252	13 043,728	12,304,639
Passengers per car-mile	4.00	3.96	3.87	3.73	4.2	3.97	4.007
Kilowatt-hours, switchboard	10,204,480	8,896,924	8,226,905	7,520,852	6.148,588	5,849,584	5,325,010
Kilowatt-hours per car-mile	2.3	2.17	2.00	1.81	1.73	1.78	1.715
Total miles of track	67.573	66.546	65.614	65.614	63.045	57.533	56.638
Number regular cars operated	84	81	80	74	70	60	60

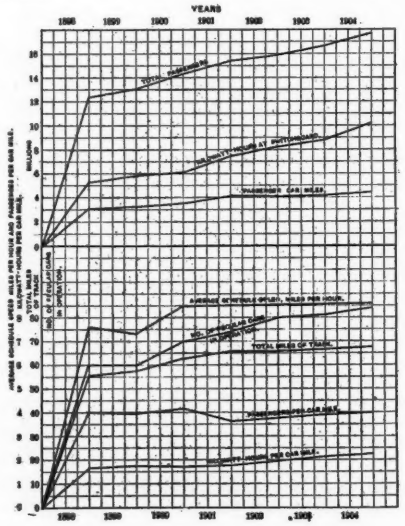


FIG. 8.—COMPARISON CURVES.

The number of trucks and motors, as determining the size and weight of cars selected; the tractive effort, and the acceleration.

The speed in miles per hour, as determining the number of cars in service; the platform labor; the demand upon power-plant equipment; the increased interest charge for line and power plant.

The gear ratio, as determining the size of motors; the acceleration; the number of stops per mile; the heating of motors, and consequent repairs; and additional power station and line requirements.

Too much care can not be exercised in determining the gear ratio for given service; for there can be no doubt that in many cases lack of power-station equipment and excessive motor repairs can be traced to the use of wrong gear ratio. In the first place, cars should be selected of ample capacity for the service requirements, and then motors should be selected with a rating only slightly greater than the service requires, and with a gear ratio so designed that the schedule may be made without resorting to rapid acceleration on starting, and, as a consequence, running the motors on low-efficiency points in order to kill time. The additional tables contained in this report show the various conditions existing in Hartford, and may be of general interest.

AVERAGE SCHEDULE SPEED MILES PER HOUR.

1898	7.6
1899	7.44
1900	8.5
1901	8.55
1902	8.55
1903	8.56
1904	8.56

APPENDIX.

CAR 138. JANUARY 16.

Temperatures are in degrees centigrade.

Motor 1:

Car in at 10.35 P. M.
Temperature of air, 0.
Temperature of armature iron, 60.
Temperature of field, 63.

CAR 101. JANUARY 17.

Motor 1:

Car in at 10.35 P. M.
Temperature of air, 1.
Temperature of armature iron, 70.
Temperature of field, 46.
Temperature of air in car barn at 6 A. M., 70.

CAR 480. JANUARY 18.

Motor 4:

Car in at 10.35 P. M.
Temperature of air, 1.5.
Temperature of armature iron, 29.
Temperature of field, 25.
Temperature in barn at 6 A. M., 23.

CAR 169. JANUARY 19.

Motor 1:

Car in at 10.35 P. M.
Temperature of air, 5.
Temperature of armature iron, 41.5.
Temperature of field, 27.5.
Temperature in barn at 6 A. M., 20.

In all the above temperature readings the temperature of the field coil was obtained by placing a thermometer on the top right-hand field coil at about the same point. The armature temperature was obtained by placing the thermometer on the iron core.

FUEL ECONOMY IN STEAM POWER PLANTS—II.[1]

BY WILLIAM H. BOOTH AND JOHN B. C. KERSHAW, F. I. C.

Radiation and Air Leakage—Loss of heat by radiation has long been recognized and it will suffice here merely to indicate its reduction to a minimum by careful covering.

Loss by infiltration of air has only lately been generally recognized as a serious matter. It was possibly first pointed out as serious by one of the authors over twenty years ago, and was ridiculed as hair-splitting. It is serious as a direct loss, as a reducer of temperature head in the external flues and in the economizer, and as a reducer of draught by cooling and choking the chimney. Glazed brickwork—recommended by the authors many years ago—might often be better employed to case in boilers than to decorate engine rooms. In the absence of glazed brick, all boiler-casing walls should be of hard pressed brick in cement, or the walls should be thickly painted until air-proof, or covered in thin sheet metal all the way to the chimney. Heat insulation of pipes depends for its effect upon the entrapping of films of air by some poor-conducting cellular or laminated material. Animal wool is probably the best heat insulator could it withstand modern temperatures. Of the many coverings sold, any maker can produce figures of test which prove his particular material to be the best, if gauged per unit of thickness, or by price, or upon some other basis. All of them are better than bare pipes. Pipe flanges must be afforded equal protection with pipe bodies, and heat insulation is of sufficient importance to warrant careful attention.

Stoking—Few men can properly stoke a furnace so long as six feet. The chief thing to aim at in stoking is even thickness, careful filling of hollow places, and complete covering of the bars, often so neglected at the front corners near the door. More steam can usually be made on the spreading than on the coking system; but in the spreading system either one side only should be fired at once, or one-half of the length, so that the excess of air through half the grate may mix hot with the gases from the other half. Bituminous coal does not burn, except as a gas, until about a third of its weight has been gasified. When stoked it chills the fire much more than would happen with so many cold stones, and the remarkable deadening of the fire is not due to this slight cause, for only about 11,000 heat units are employed in raising a charge of one-half a hundredweight to 1,000 degrees Fahrenheit of temperature, or say two-third pounds of coal. The cooling is due chiefly to absorption of latent heat by the production of gas. A piece of coal is obviously carbon plus some solid variety or varieties of hydrocarbon unknown to the chemist, with a mean proximate empirical formula C_7H_5. Chemists only know the various heat distillates, and, as in all operations involving change of state from solid to liquid, and liquid to gaseous, the change of solid coal into gaseous compounds demands heat. In burning bituminous coal on a grate, much of the calorific capacity of the fuel is absorbed as latent heat by the newly distilled gas, which renders it up again when burned later. Coke or anthracite, producing little or no gas, burns at or near the grate, and produces a clear bright fire. Bituminous coal can not be thus burned. It must have time, and space, and temperature, and the least time and space are demanded when the temperature is highest.

Mechanical stoking can not abolish these facts, nor can it possibly be a panacea for the smoke evil. Mechanical stoking does permit the use of inferior or rather smaller coal, and it tends to render more uniform the régime of the furnace. It does not render grate cleaning unnecessary, and it is not, therefore, a perfectly continuous process with the ordinary moving bars. In a coking stoker which feeds fuel to one end of a grate, the action as regards smoke production and burning is perfect, for the coked fuel tumbles into a pit behind the grate and burns out there as in a gas producer. The grate is short and the coal never burns very thin upon the bars in such a stoker as the Vicars which aims to keep down air excess by this means. In the chain grate without a back pit, the fuel burns out on the grate, and large volumes of excess air get in at the back end. This renders economy impossible, unless means are taken to regulate the admission of air to different sections of the grate in accordance with the demands of the fuel. Air admission above the fire is regulated by grids in the furnace door. The opening for air may be four square inches per square foot of grate. Such grids are regulated by hand, or by clockwork or similar devices. In mechanical stoking the air supply gets in more or less incidentally through the fuel hopper and through casual openings, and often in far too large amounts in the rear of the grate.

Mechanical stoking does not eliminate the need for correct furnace forms, or for sufficient temperature and proper mixture of air and gas. All inventors and purveyors of furnace accessories, such as grate bars, air-admission devices, stokers, etc., appear to become possessed of one idea, and this they push for every case, overlooking the fact that the combustion of bituminous coal is a complex chemical process which can only be conducted where the chemical equivalents are present to combine, and the further essentials of combustion are ensured. Theoretically, perhaps little air beyond the chemical equivalent would be required were the furnace continued to so great a length that ultimately every molecule of combustible came into contact with its molecule of oxygen. This assumes a heat-conserving furnace.

Practical considerations render it necessary to reduce the extent of the furnace, and to add an excess of air, so as to ensure oxygen coming into contact with all the combustible elements of the fuel within the zone of sufficient temperature. It should be possible to do this with twenty-five to thirty-three per cent of air in excess, and certainly with less than fifty per cent excess. The flame of bituminous coal will be longer, as the heat is kept low, so that a suitable furnace has a cumulative effect. By conserving temperature flame is shortened, and by shortening flame the necessity for long-protected furnace surfaces is reduced. So far as the authors are aware there is no ordinary chain grate that does not pass an unnecessary and grossly excessive volume of air. Until this furnace is tried with a less wasteful form of grate, no absolute opinion can be passed upon its proportions, though its principles are correct.

The manufacture of a maximum of carbonic acid gas per unit of fuel consumed, or rather per unit of air used, is what should be the aim of a stoker. High CO_2 means high furnace temperature, high heat transmission, small weight of waste gases, and general furnace economy. *Per se*, black smoke may not indicate serious waste of fuel; but it is evidence that the boiler surfaces are covered with non-conducting soot, and black smoke is an incentive to buy more costly coal of a less smoky order.

The Weir water-tube boiler is an example of the same principle, scarcely different in the way it is carried out. Coal is burned in a V-shaped furnace, the walls

[1] A paper read before the Institution of Electrical Engineers, London, England, January 12. The first part appeared in the ELECTRICAL REVIEW, February 25.

on all four sides of which are of firebrick, and combustion is continued in a similarly protected chamber, and is perfect with ordinary hand-firing before the heated gases pass among the tubes.

The chain grate stoker is perfect as a self-cleaning contrivance, but admits excessive air. Hence the need of choking boxes, as employed by Mr. E. B. Coxe. These difficulties with traveling grates are responsible for the sprinkling form of stoker, which, when in good order, keeps the grate evenly covered, as the coal tends to fill the hollow places. But the winnowing action of the draught carries off the dust to become a public nuisance. Such stokers require initially providing for, in the design of a chimney with a settling chamber to gather the dust. The economy of mechanical stokers lies in their ability to raise sufficient steam with cheaper coal than hand-firing demands, and in the reduction of the stoking staff. But mechanical stokers will not be an economy unless their hoppers are filled mechanically, and they ought to be in charge of a skilled mechanic to look to upkeep and maintenance, and not be expected to run with unskilled attention.

The ideal mechanical stoker is of the inclined grate type in which the inevitable thinning of the fire of the coking furnace is made good by the aid of a moving grate assisted by gravity. In this type, only possible in its full extent with external furnaces, the fuel is helped to fill gaps and close the lower end of the fire by gravity, and at the foot of the inclined grate is some arrangement which enables ash and dirt to be removed. Rocking grates which profess to cut out the ash and clinker from the underside of the fuel bed are of doubtful use, for clinker is tough and adhesive when hot. It becomes brittle only when chilled, and users of such bars should be prepared at least to have each half of the grate workable independently. The system may then be used to clean a grate quickly, after the clinker has been chilled by removal of the fire to the other half of the grate.

Smoke Prevention—This can often be managed by excessive air admission, for the reason, probably, that though air in excess has a chilling effect, its ample provision enables all the gases to burn before they have lost much temperature. But smoke can not be prevented with economy unless sound conditions are present, as already detailed, and the crux of the whole matter is summed up in saying that a maximum percentage of CO_2 must be present in the furnace gases.

Could the furnace products be rejected at atmospheric temperature, an excess of air would be of no account. But the heating surfaces commercially available render it impossible to cool rejected gases below, say, 400 degrees Fahrenheit whatever the supply of air, and obviously the loss of heat is greater where air is used in excess. This point is emphasized because there is frequently a serious confusion of thought in relation to heat and temperature, and the weight of the gases possessed of such heat or temperature. Cold flue gases, unless of small weight per unit of fuel, do not represent economy, but excess of air. Some people think otherwise.

STEAM.

The object of burning fuel under steam boilers is to produce steam. Steam at atmospheric pressure contains about 967 units of latent heat and 160 units of sensible heat above feed temperature. Only by means of the latent heat can work be done. These facts make it of prime importance that when steam is used it should contain all possible latent heat. It should be steam, in fact, and not hot water. Steam loses heat from the moment it leaves the boiler. The surfaces which contain it must, therefore, be of a minimum area. This involves pipes of minimum length and is one of the various reasons for avoiding ring mains, the fancied need for which is obviated by using good materials well put together for steam piping. Short pipes make it possible to carry a given weight of steam with less drop of pressure, or otherwise to carry the same steam at the same pressure fall through smaller pipes.

The loss of heat through pipes varies with the head of temperature. The weight of steam that will flow through a pipe varies with the pressure absolute very nearly. The pressure of steam rises faster than the temperature, and high-pressure steam (realized to be economical) will lose less heat than low-pressure steam, if the pipes are as much smaller as they should be for the high pressure. It is a mistake to employ steam pipes so large that there shall be no appreciable fall of pressure. Some fall, three pounds to five pounds, per square inch may be allowed in long pipes, for there is a point where the saving due to high pressure will be lost by the extra radiation from the larger pipes. Wet steam travels with more friction than dry steam. Superheated steam, despite its greater head of temperature, loses heat less rapidly by contact than does wet steam; it flows with less friction and loses less at joints. Less of it is also required, and pipes may be smaller.

There is no thermodynamic gain from superheat. Steam leaves the boiler at boiler temperature; it starts expanding at boiler temperature. The work done on the piston during admission comes directly from the fire, or is done by expansion of saturated steam in the boiler. The superheater is merely an incident in the steam pipe. The sole function of superheat is to ensure that steam, saturated with heat, and at maximum density per cubic foot for its pressure, shall be present in the cylinder to work expansively when steam is cut off from the boiler. Superheat is thus intended to heat the cylinder as hot as the boiler, and, by avoiding the presence of water in the cylinder, to minimize the exchanges of heat between the cylinder metal and the steam. Superheated steam supplies heat directly to the cooled surfaces which require it. The jacket, on the other hand, endeavors to maintain the outside of the working liner of the cylinder as hot as the boiler, and, while it may do some good in certain cases, it is always liable to do little else than evaporate water of condensation during the exhaust period.

The steam engine, being a heat engine, it is obvious that the best working fluid is that which contains a maximum of heat in a unit of volume. This is what saturated steam does contain, and the object of superheat is to supply saturated steam to fill the cylinder at the time of cut-off. Superheated steam is still often erroneously claimed to owe its superiority to the fact that less of it will fill a given space at a given pressure than is the case with saturated steam. This argument ignores the rapid drop of pressure which occurs when superheated steam expands. It ignores the fact that in a given bulk there is less heat and therefore less capacity for doing work. Therefore, while superheat is essential to economy, it is so only because it is the one means we possess of filling a cylinder with dry saturated steam.

(To be continued.)

Technical Education in France.

United States Consul Hilary S. Brunot, at St. Etienne, France, in a recent report, described what is being done along the lines of technical education in France. The work of the National Institute of Arts and Trades, Paris; the Central School of Arts and Manufactures, the High School of Commerce, the High Commercial School, the School of Arts and Trades, the National School of Workmen and Foremen, Cluny; National School of Watchmaking, at Cluses, and professional schools, is described.

THE MUNICIPAL ELECTRIC PLANT IN NEW YORK CITY.

AN ANALYSIS OF THE REPORT OF THE MAYOR'S COMMITTEE.

On February 10, the commission appointed by George B. McClellan, mayor of New York city, made public its preliminary report on a municipal electric plant. The salient features of the report are as follows:

A power station having a capacity of 10,000 kilowatts, to cost exclusive of real estate, $1,250,000. Cost of building plants for providing 6,000 arcs and 250,000 sixteen-candle-power incandescent lamps is $4,100,000, exclusive of the cost of real estate. Cost of high-pressure cables, substations and other details is $2,850,000. Cost per year of arc lights, including interest on bonds and depreciation of plant, is $75.40. Cost per year of sixteen-candle-power incandescent lamps is $5.15. Total annual cost of operating the proposed plant is $906,000.

To these figures Mr. Ernest H. Davis, president of the National Electric Light Association, takes exception. His ideas are embodied in the following open letter:

"In the report upon the proposed municipal lighting plant submitted to the mayor by the engineering committee, a number of items are omitted, some intentionally, others apparently not. And there is at least one error of a very glaring nature in the principal figures upon which the conclusions are based.

"The report admits the omission of lost taxes, of the principal real estate costs and of all subway charges. The result; quoted generally as comprehensive, is therefore only a partial statement of the cost of operating the municipal plant. It is not stated, however, that the large expenditures required to replace the electric motors and other apparatus, and to equip the buildings now using gas for electric light, are omitted. Every motor now used for an elevator, pump, for ventilation or for any other power purpose, in any school or other public building must be changed to utilize the new system, which differs radically from the present system of the private companies.

"In the various public buildings now supplied by the private companies there are 75,000 incandescent lamps. For the new conditions the engineers have estimated upon 250,000, leaving a balance of 175,000 to be wired for and provided with fixtures. The cost of this equipment and of changing the motors will be not less than $1,000,000, to which must be added the fees of the engineers, which their report places at ten per cent of the amount expended. The inclusion of this one item, of a number, for which the report makes no provision, will increase the estimated expenditure for this proposed municipal undertaking by not less than twenty-five per cent.

"There is another error greater in magnitude and more inexcusable in nature. The original report of the chairman of the present committee stated that 4,000,000 kilowatt-hours annually at the lamps would be required to supply 160,000 incandescent lamps of sixteen candles. The present committee have increased the incandescent installation to 250,000 lamps which on the same basis of consumption will require 6,250,000 kilowatt-hours. At 5.15 cents a kilowatt-hour, the estimated cost given by the committee, the annual expenditure for operating this portion of the plant will be $321,875. The total expenditure is $906,000. A balance is therefore left of $584,125—chargeable to arc lighting—which is $97.35 per arc lamp, and not $75.40 as stated in the report.

"Another error has crept into the report figures, arising possibly through some lack of familiarity with the question, though the necessary data were available to the expert committee. In all the public buildings, the armories, schools and various departments, the city is now using 75,640 incandescent lamps of the equivalent of sixteen candles, which use annually an average of 13.75 kilowatt-hours. On the same basis the annual consumption by 250,000 incandescent lamps would be 3,437,500 kilowatt-hours, which at 5.15 cents a kilowatt-hour would cost only $177,031.25. This change would make very slight difference in the total cost of operating the plant, and therefore if the contention of the engineers that they can make current for 5.15 cents a kilowatt-hour is correct, we must increase the charge against the arc lighting to $728,968.75, which is an average of $121.49 per lamp, again not including lost taxes, real estate and subway costs.

"It would probably not be entirely fair, however, to charge the entire difference against the arc lighting, but rather the estimated cost of producing the incandescent service must be largely increased. Where reduction is made merely in the amount of current generated by a plant of fixed size the costs of generation do not decrease in like proportion. The fixed charges, including interest, depreciation, taxes and other general expenses, remain as before and labor remains. The difference in such an instance as this would be but a slight change in coal and water. Any diminished wear and repairs upon the machinery are negligible. And therefore instead of charging the difference against the arc lighting it would be more nearly accurate to divide the cost of generation by the correct consumption of current; the partial costs thereupon become instead of 5.15 cents, 9.36 cents a kilowatt-hour. Loss of taxes and the principal real estate and the subway costs still are not included.

"This figure also fails to include the large expenditures which must be made to utilize the proposed service, and they are of such a nature that they must be charged exclusively to the incandescent lighting—the estimates for which include power. Upon interest and depreciation, taking the figures of the report together eleven per cent, a total of $121,000 annually must be added to this account. There would be an additional expenditure for the maintenance of these installations, but I have purposely omitted this item. This additional sum alone represents an increase of 37.5 per cent, bringing the cost of this service to 12.88 cents a kilowatt-hour, still excluding the subway, tax, and real estate items.

"A further word upon the arc lighting. It is a matter of simple arithmetic in your own hands to find from the report itself that the partial cost of the arc lighting is $97.35 annually. Adding the omitted items of lost taxes, the principal real estate costs and subways, the final cost becomes in no sense competitive with the prices that may now be obtained from the private companies. The largest item omitted relates to the subways, under the assumption that they must be provided at the expense of the subway companies —but this, I presume, is a legal question. Ex-Mayor Matthews, of Boston, after an exhaustive examination upon the subject reported to the authorities of his city that underground service, such as that of New York, added thirty-nine dollars annually to the cost of an arc lamp. If anything, these figures err on the low side. The experts have omitted lost taxes from their estimates on the ground that with the installation of this plant 'taxation of the existing companies would not be affected.' It is not supposable that the private companies would continue to pay taxes upon a service they do not render, or from which they receive no revenue.

"Recapitulating we have the following: (1) that the partial cost of the incandescent lighting service if supplied from a municipal plant would be not less than 12.88 cents a kilowatt-hour; still excluding subway, tax and real estate items. The private companies now quote the city twelve cents a kilowatt-hour and in some buildings six cents, in each instance the price being inclusive of incandescent lamps, the supply of carbons and the care and maintenance of arc lamps. (2) That from the report the partial cost of an arc lamp is shown to be $97.35 annually, and that the entire cost, inclusive of subway, real estate and lost taxes, would be in excess of $140—the present maximum price of the private companies.

"Without speaking for the companies, for whom I have no authority to speak, I am convinced that were they offered, to even a limited extent, the advantages enjoyed by this proposed plant, either in a fairly long-term contract for the present service or a year-to-year contract for a service as large as that proposed, reductions from their present prices would be made. For, permit me to point out the private companies are now serving less than half the aggregated installation of the proposed enterprise.

"To a communication that has already gone beyond reasonable limits, may I add that the method proposed by the expert

committee is inferior to the system by which the city is now lighting. One feature of inferiority is the absence of the reserve found in the storage batteries of the private companies. These batteries alone, which at all times stand behind the public lighting, have cost fully half the entire proposed expenditure on the part of the municipality. One result would be that were an accident to occur either at the main or any substation a large section of the city would be placed in absolute darkness. In fact, in the system planned it is proposed to give up all the advantages of the present low-tension direct-current system which has been brought to an almost perfect state technically through years of study, development and the expenditure of millions of money.

"It is to be hoped that this entire question will be passed upon by more adequate and competent authority and from a standpoint entirely disinterested, unprejudiced and impersonal before the city is committed to an enterprise from which once launched there would be no turning back."

Peculiar Photographic Action.

A peculiar photographic action has been discovered by Mr. G. W. A. Kahlbaum, of Bâle, Switzerland, which is described in *Engineering* (London), February 10. While studying the effect of density on gravitation, and the transparency of metals to Rœntgen rays, he noticed that the metals themselves had photographic action under the following circumstances: placing a sensitized plate, film upward, in a box of cardboard lined with black paper, and placing over the film a strip of paraffin paper, pieces of cardboard and pieces of sheet metal, in the order named, and then in the reverse order, with a second photographic plate on top, and allowing the combination to stand for several days, a distinct photographic action was seen on the lower film. The metals used were aluminum, iron, zinc and lead, but the impression was found only upon the film below the pile of metal sheets—not on that above. The action was strongest in the case of zinc. These pieces of metal had previously been exposed to Rœntgen rays and other experiments; a special set of metals which had not been used in any way was obtained. Photographic action again took place, and, as before, only upon the lower photographic plate. This seemed to indicate that the effect was due to gravitation. When several photographic plates are piled one upon the other, underneath the metal, all are affected, the one nearest the metal being most strongly impressed. When the plates are placed vertically, instead of horizontally, there is no difference between the images produced on the right and left sides.

RAILWAY SIGNAL SYSTEMS.

BY AZEL AMES, JR.

The impression which the large number of train accidents during the last year has made upon the public mind is very strongly evidenced by the rather drastic legislation that is being introduced in some states and by the interest that is being taken all over the country in the further adoption of safety appliances by the railroad companies, particularly along the lines of block signaling.

While the most that will be done immediately by many of the roads will be the adoption of a simple form of telegraphic block system, a number of the larger roads will go very heavily into automatic block signaling the coming season. The Lake Shore and Michigan Southern are spending considerable money along these lines and a number of other roads are going quite heavily into the automatic field; even the extreme western roads are going in for a lot of automatic blocking on their single-track lines, not, of course, with the intention of entirely doing away with train despatching, but as a valuable adjunct for increased safety and for expediting the movement of trains.

While undoubtedly there will be a great deal of stimulation given to invention and designing of signaling apparatus, it is doubtful if there will be much variation in the next few seasons in the types of signals now being put upon the market. There is a strongly growing tendency toward the use of storage batteries for automatic motor signals where the blocks are of such lengths, the traffic of such volume and the number of tracks to signal of such a number as to warrant the cost of a transmission line. The coming season will perhaps see a decrease in the number of semaphores operated by primary battery and a fair increase in the number of electro-gas signals put in use and quite a heavy increase in the number of motor semaphores operated by storage batteries. A number of roads are at present operating their motor signals by storage battery, taking the battery to some point of advantage for the purpose of charging it. This is being done on the Southern Pacific and Mr. Slater claims an economy over the cost of operation by primary battery. It would appear that where automatic block signals are to be operated by a self-contained source of energy, that the electro-gas signal will increase in favor, those at present in use having given a high degree of satisfaction to the roads using them.

There is a strong tendency toward the use of all-electric interlocking even at points where the cost of installation of mechanical interlocking would be somewhat cheaper. There is hardly any doubt but what electric interlocking will be shown to be slightly more expensive to maintain than the mechanical, but there is no doubt of its greatly increasing use on account of its great advantages and very satisfactory performance under proper maintenance.

The General Railway Signal Company has until recently had practical control of all the all-electric interlocking in the country, but the Union Switch and Signal Company is developing what will undoubtedly turn out a very efficient apparatus and system. Of course the various roads are daily besieged by inventors and others with all sorts of schemes and all sorts of safety appliances. Quite a number of these are along the lines of some form of cab signal or automatic train-stop. While there is bound to be advance along these lines of signaling, and while under certain conditions of low speed on structures or in tunnels the automatic train-stop is giving satisfactory service, it is not likely that extensive applications of either the train-stop or cab signal will be made on steam roads in the immediate future. Signal engineers are all looking anxiously for the development of an alternating-current apparatus for railway signaling, the chief trouble with all automatic work at present being the use of direct current for the track circuit and the consequent interference therewith of foreign current. While it is true that very satisfactory alternating-current relays have been devised and are in service, there has not yet been developed a form of alternating-current magnet suitable for signal clutches or slots. Until such have been perfected we probably shall not see the introduction of much alternating-current signal apparatus.

Amusement Telephones.

The Orpheum Theatre, Brooklyn, N. Y., is engaged in an experimental test of connecting its patrons by telephone, and enabling them to enjoy the vaudeville performance without leaving their homes. Quite recently a demonstration was made, a number of prominent Brooklynites being connected up to the telephone system, and enjoying the entire performance.

Almost directly in front of the stage there is a receiving apparatus which is fitted with a specially constructed diaphragm. This sends impulses over a trunk line which is tapped by any number of individual line circuits. The tests are being conducted over the system of the New York & New Jersey Telephone Company. It is possible that, if the experiments are satisfactory, the service may be installed, not only in private homes, but at hotels and restaurants throughout the city.

Report of the Directors of the New York & New Jersey Telephone Company.

The twenty-second annual report of the directors of the New York & New Jersey Telephone Company, for the year ending December 31, 1904, shows substantial gains in both the Long Island and New Jersey territory covered by the system.

The gross earnings were $5,393,708.76. The expenses of operation were $3,729,335.35. Earnings over operation were $1,664,373.41.

FIXED CHARGES AND TAXES.

Interest	$66,422.04	
Taxes	121,000.00	
		$187,422.04
Net earnings applicable to dividends		$1,476,951.37
Dividends paid		962,088.50
Surplus earnings, 1904		$514,862.87
Surplus, January 1, 1904		3,071,099.06
Surplus, December 31, 1904		$3,585,961.93

COMPARISON.

	1904	1903	Changes
Gross earnings	$5,393,708.76	$4,741,343.90	$652,364.86 inc.
Expenses of operation and maintenance	3,729,335.35	3,269,996.38	459,338.97 inc.
Earnings over expenses	$1,664,373.41	$1,471,347.52	$193,025.89 inc.
Fixed charges, taxes and dividends	1,149,510.54	1,033,429.77	116,080.77 inc.
Surplus	$514,862.87	$437,917.75	$76,985.12 inc.

The results of the year's operations show increase in both gross and net earnings. The company has been particularly fortunate in having escaped severe storms.

Under date of January 26, 1904, the directors offered to the stockholders at par $1,252,000 of treasury stock, which was duly subscribed and paid for during the year.

Under the operation of the sinking fund, the amount of the company's general mortgage bonds outstanding was reduced $18,000, leaving the amount of outstanding bonds at the close of the year $1,268,000. There have been purchased for the sinking fund and cancelled since the issuance of the general mortgage in 1900, $232,000 of the bonds secured by it.

The expenditures for extension of plant and new construction during the year were as follows:

Real estate	$82,717.90
Equipment	478,394.46
Telephone lines	783,444.20
Making a total am unt charged to construction of	$1,344,556.56

The large outlays for construction and maintenance during the past few years, with the general extension of the company's underground system, both in the important cities and towns of its territory and on the main trunk lines running out of the city of New York, have placed the plant in a sound and permanent condition. The extended use of the Pupin coil, together with the improved common battery switchboards, which have now been widely installed in the important exchanges, have resulted in a substantial improvement in the quality of service which the company is able to render.

Five new buildings of fireproof construction, for the use of important exchanges, have been completed and occupied during the year. Chief among these is the large six-story building known as the Prospect Central Office in Brooklyn, in which have been placed the equipment for the Prospect district, the Long Island trunk switchboard and the general force of the Long Island division. Sites have been secured also and work commenced on four other buildings, to be located at West Brighton, S. I., and at Montclair, Newark and Morristown, N. J. These buildings will be completed during the year, and work will be commenced upon several additional properties.

From time to time, the directors have authorized modifications and reductions of rates to meet the constantly changing conditions. On October 1, 1904, a general revision of toll rates, involving substantial reductions, was put in effect throughout the territory.

On September 1, 1904, under an agreement effected with the Delaware & Atlantic Telegraph and Telephone Company, the company assumed control of a portion of the territory formerly operated by that company in Ocean County, N. J., but which was naturally tributary to the New York & New Jersey Telephone Company lines. At the same time the company transferred to the Delaware & Atlantic company a small portion of territory theretofore operated by the New York & New Jersey company in Middlesex County, N. J., where the business was naturally appurtenant to the lines of the Delaware & Atlantic company.

During the year the office of chairman of the board of directors was created, and some other changes were made in the plan of organization of the company, looking to a more efficient arrangement of its force, in order to properly care for its complex and rapidly growing business.

In the month of September occurred the death of Mr. David B. Powell, for many years a member of the board of directors. At a meeting of the board, held shortly thereafter, the following resolutions were unanimously adopted:

Resolved, That in the death of Mr. David B. Powell this board has lost a member whose high character and sterling qualities of heart and mind his associates have always held in the highest esteem.

For more than fourteen years Mr. Powell has been an active member of this board, ever showing a keen interest in the affairs of the company, and on all occasions giving counsel and advice of the highest value.

Resolved, That we tender our deep sympathy to Mr. Powell's family in their bereavement, and that, in common with his other friends and associates, we bear tribute to his genial nature and his capacity for large affairs, which was so signally marked by integrity and worthy purpose.

Resolved, That these resolutions be spread upon the minutes of this board, and that the secretary transmit a copy thereof to the family of Mr. Powell.

The directors express their appreciation of the loyal cooperation of the employés of the company, the intelligent discharge of whose duties has contributed very greatly to the successful result of the year's operations.

The total number of stations are shown in the following summary:

	L. I. Div.	N. J. Div.	Total
Stations, Jan. 1, 1905	39,544	40,780	80,324
Stations, Jan. 1, 1904	32,471	34,093	66,564
Gain	7,073	6,687	13,760

The officers and directors of the New York & New Jersey Telephone Company are as follows:

Chairman, Charles F. Cutler.

President, U. N. Bethell.

Vice-president, William D. Sargent.

Secretary, Waldron Hoppins.

Treasurer, Henry Sanger Snow.

General manager, J. C. Reilly.

Executive committee, Charles F. Cutler, William D. Sargent, Jos. P. Davis, Frederick P. Fish, U. N. Bethell.

Directors, Charles F. Cutler, New York, N. Y.; Alexander Cameron, Brooklyn, N. Y.; Jos. P. Davis, New York, N. Y.; Charles A. Nichols, Springfield, Mass.; Hugh Kinnard, Newark, N. J; William D. Sargent, Brooklyn, N. Y.; George H. Prentiss, New York, N. Y.; Edward J. Hall, New York, N. Y.; Henry Sanger Snow, Brooklyn, N. Y.; Zenas Crane, Dalton, Mass.; U. N. Bethell, New York, N. Y.; Frederick P. Fish, Boston, Mass.; John W. Griggs, Paterson, N. J.; Theodore F. Miller, Brooklyn, N. Y.; James Jourdan, Brooklyn, N. Y.; Wm. C. Courtney, Brooklyn, N. Y.; Waldron Hoppins, Brooklyn, N. Y.; William Berri, Brooklyn, N. Y.

American Institute of Electrical Engineers.

The 194th meeting of the American Institute of Electrical Engineers was held in the chapter room of Carnegie Hall, New York city, on Friday evening, February 24, 1905. President Lieb was in the chair. The secretary announced the death of Mr. Eugene F. Phillips, of Providence, R. I.

The first paper of the evening was then presented, namely: "Two-Motor *versus* Four-Motor Equipments," by N. McD. Crawford. This paper appears in full on another page of this issue. Mr. Crawford himself was not present, and the paper was read by Dr. Samuel Sheldon. At the conclusion of the paper Dr. Sheldon read a letter from Mr. Crawford, in which he explained the term "A" in the efficiency formula in the paper. He stated that the value of A is obtained by multiplying the average watt-hours per ton-mile by ton weight of car, and this result by the cost of power per watt-hour at the switchboard. Mr. Crawford stated that it seemed important also to use the cost of current per ton-mile at the switchboard, the value of the seated load, platform labor per mile run, and the interest and depreciation per mile run, considering these terms as input, and the returns per mile as output in determining the efficiency. He stated that it would be extravagant practice to run a heavy, high-speed, expensive car of large seating capacity over a line from which a small earning capacity would be returned—due to density of population and other causes—when a lighter, slower-speed, less expensive car of smaller seating capacity would fully accommodate the travel and produce an efficiency nearer 100 per cent. Mr. Crawford stated that he had endeavored to name the efficiency obtained "commercial efficiency," but that possibly this was erroneous, and that it might be better to name the figure obtained "load-factor" or "earning efficiency." He said, however, that he was looking at the matter from the standpoint of a street railway manager, and not from an engineering standpoint.

President Lieb then called on Mr. A. H. Armstrong, Schenectady, N. Y., to open the discussion. Mr. Armstrong stated that the contest between two and four-motor equipments seems to have been settled in favor of the four-motor equipment. He held, however, that each case must be settled for itself, according to local conditions. The fundamental reason for four-motor equipments is the need of increased traction, the increase being due to hilly routes and rapid acceleration. City roads particularly need the rapid acceleration on account of the many stops, and on a surface line four motors are necessary in order to obtain this rapid acceleration. On a road having good rail surface, such as an elevated or subway road, the two-motor equipment is sufficient to give the train rapid acceleration without discomfort to passengers. Suburban work is different, one-car trains being run, and hills which would not be tolerated on a steam road being encountered. The climatic conditions also affect the operation of trains. With a high-speed road, with cars running at from fifty to sixty miles per hour, the proper schedule can only be maintained by means of four motors—one on each axle. The two-motor equipment is perfectly satisfactory for light city traffic, where the road has a low profile and many stops. Mr. Armstrong criticised the efficiency formula, and said that it did not, in all cases, give true results. He called attention to the fact that if a two-mile run had been taken as a basis, instead of a one-mile run, the efficiency of car No. 169 would have been about doubled. He stated that there was no reason why a car should demand more energy with four motors than with two, if the weight on the wheels is the same. He also thought that a car equipped with two thirty-five-horse-power motors should not be compared with a car equipped with four thirty-five-horse-power motors, but that a car equipped with four thirty-five-horse-power motors should be compared with one equipped with two seventy-horse-power motors. He thought that the only fair basis of comparison of two and four-motor equipments is due to local conditions, and that the trend of public opinion seems to favor four motors.

Mr. S. T. Dodd was then called upon to continue the discussion. He criticised the efficiency formula, and stated that it does not, as it stands, mean efficiency in the sense that an engineer would state it. He criticised the introduction of the term "seat value," and thought that Mr. Crawford should have given two formulas, and used the carrying capacity of the car in one. He thought that the cost of repairs should have been added to the table of operating expenses, as the vital question is, do two motors cost less than four for repairs? He pointed out that if the cost per seat-mile had been obtained, instead of the cost per car-mile, car No. 480 would have been the most economical. He stated that more data on repairs were necessary, and that these data should be cost of repairs per motor, instead of per car-mile. In regard to the question of heating, he said that it was often stated that a two-motor equipment on the same load and service as a four-motor equipment will heat quicker on account of the smaller motors having a greater proportional radiating surface. He questioned the truth of this, however, and cited some tests made by himself on a number of different motors, in which he found no practical difference. He stated that the difference in the heating of motors on the cars mentioned in the paper was not due to difference in motors, but difference in gearing. He said that Mr. Crawford's curves showed that two of the cars were geared too high for their service.

Mr. Calvert Townley, New Haven, Ct., stated that in the comparison of two and four-motor equipments, two motors and four motors are not strictly compared; that the comparison is one of local conditions. In any given city, the comparison should first determine what type of car is best suited to the service, and then whether two motors or four motors were the best equipment for that car. The question of gear ratio should not be brought in when the equipments are under comparison. Another difficulty encountered is that four-motor equipments are usually compared with two-motor equipments of lower aggregate capacity. If we assume exactly the same capacity of motors, the corresponding four-motor equipment is heavier and must be made larger to account for the difference in weight; therefore the cost will be greater. The difference is not great if the motor capacity is the same, but it will be considerably greater if the motor capacity per ton weight is considered. The cost of maintenance is greater with four motors, on account of the greater number of parts. All the foregoing points are against the four-motor equipment. Four motors, however, give increased traction, which is needed with high speeds, and four-motor equipments must be used when the needed motor capacity can not be obtained with two. The conditions in winter are very different from those obtaining in summer. In winter frequently one truck has no adhesion whatever, and the motor or motors on that truck are not available to start the car. With a two-motor equipment this might result in stalling the car. In summer, however, there were few conditions where a two-motor equipment would not give perfectly satisfactory service. Regarding the efficiency formula, he

stated that the question of efficiency is considered a question of interest and depreciation on car equipment, and that the interest on track and overhead work should also be considered, as they increase with a heavier equipment.

A paper entitled "On Track Bonding" was presented by Mr. C. W. Ricker. In this paper the history of rail bonding was first taken up, and the different types of rail bonds classified as follows: first, compressed terminals, in which a hole is drilled or punched in the rail, and the cylindrical terminal of the bond is upset in it by great pressure; second, expanded terminals, in which a terminal of cylindrical form is expanded in the hole in the rail by means of a drift driven through a hole in the terminal; third, soldered terminals, which is a flat terminal soldered to the surface of the rail either with soft or brazier's solder; fourth, amalgamated terminals, the terminal of a copper bond, and the surface or a hole in the rail being amalgamated and held in contact with slight pressure, depending upon a layer of tin amalgam maintained in metallic contact; fifth, bolted terminals, in which copper strips or sheets are pressed against the surface of the rail by bolts designed for the purpose; sixth, makeshift terminals, which are of many forms, and are used mostly where there is no money with which to get those of better design.

A good bond should be so formed that it may be applied with the types of rails in ordinary use, in such position as to be protected from accidental damage and from theft. The bonds should be readily accessible for inspection and repair. The cost of application must be kept low, and to this end it is very important that the process shall be so simple and easy that no high-skilled labor or extraordinary care is required to install them with certain and uniform results. The bond that satisfies all these conditions has not yet been devised. No standard has so far been adopted for the ratio of contact area to cross-section of bond. The practice seems to be to get as large contact area as is possible. The failure of a bond is usually due to one of three causes, namely: breakage of bonds, disintegration of bonds, and the impairment of contacts. The breakage may occur because of defects in manufacture or fatigue from long-continued jar and repeated flexures. The bond may become disintegrated at the surface of imperfect welds. In an amalgamated bond the amalgam may harden and shrink, losing flexibility and contact with the bonded surface. The most important cause of impaired contact is oxidation, which is greatly facilitated by the presence of moisture. Soft soldered contacts under ground are not to be trusted, especially on track laid in streets which are sure to be wet. Brazed bonds seem to give no trouble.

Attention is called in the paper to the importance of good contact, and instances are cited to show the efficiency and durability of the different forms of bonds.

The discussion was opened by Mr. Henry A. Lardner, of New York. He regretted that the perfect bond described by Mr. Ricker had not been devised, and stated that the difficulty of obtaining a perfect bond seems to be due to the difficulty of obtaining a good contact between the rail and the bond. He thought that an entirely new method of bonding must be devised. He believes that a proper method of welding can be worked out—one that can be readily inspected and successfully applied. The quality of a bond depends so much on the quality of labor employed that it is impossible to tell, at any time, whether a good bond is obtained. Holes in the rail should be reamed, and it is possible that the bond terminals should be machined so as to obtain a better fit than is possible with any bond now on the market. He believes that, with heavy traction, the plug bond now in use must be replaced by some other which will ensure better contact. The question of maintenance is very severe. On roads operating under steam road conditions bond gangs have been able to replace only three or four bonds per day. He believes that it may be possible to use the splice bars as a bond with some form of outside connection, so that the rail may be bonded without removing the splice bar.

Mr. A. A. Knudson, New York city, called attention to the method of bonding which was not mentioned in the paper, namely, that in which an iron bar is welded to the joint, the bar being heated electrically and hydraulic pressure applied. He quoted a sentence from the paper, which stated that "in the bonding of elevated railways using steel structures, the metal of the structure has been used to excellent advantage. However, this presents some peculiar problems in bonding, and a serious risk of electrolysis of anchor bolts." Regarding this, Mr. Knudson stated that when the elevated structure was compared with that of the pipes underground, but little current would go from the structure to the pipe. He related the result of poor bonding on a railroad near New York city, where a large water main was entirely destroyed by electrolysis.

Mr. William Pestell, New York city, stated that he had had occasion to note the various types of bond. The exposed type of bond deteriorates more rapidly when in a street and accessible to moisture than when it is installed on a private right of way. With steel terminal bonds he has found that, after ten years' service, the steel terminal was as good as on the day it was put in. The only corrosion found was at the joint of the steel and copper.

Mr. R. D. Mershon, New York city, stated that the author had not taken into account the effect of increased conductivity in the bond, and electrolysis; that if the current-carrying capacity of the bond was increased, there would be less tendency of the current to leave the track. He stated that electrolysis was becoming a more serious question all the time, and that more account should be taken of it.

Dinner of the Electrical Contractors of New York City.

The banquet of the Electrical Contractors' Association of New York city was held at the Hotel Astor, Monday evening, February 27, about two hundred well-known electrical men and their guests being in attendance. The dinner was one of the best that Landlord Muschenheim has yet served, and was appreciated by every one. A very entertaining vaudeville performance followed the dinner and continued until a late hour.

At each plate was a small bag labeled "An Electrical Contract," which on being opened was found to contain a Sterling incandescent lamp in the form of a plump young pig. This souvenir, it was said, represented an electrical contract in the sense that such contracts are often a "pig in a poke." A hand-painted card bearing a motto and the diner's name was at each plate, many of the mottoes being particularly appropriate to the individual.

The officers of the Electrical Contractors' Association are: president, J. C. Hatzel; secretary, G. W. Russell, Jr., and treasurer, J. P. Hall. The very competent dinner committee consisted of Messrs. S. Davis, Fred Pearce and E. S. Keefer, and in addition to these among the others present were H. B. Kirkland, J. B. Olsen, P. H. Klein, Jr., Charles L. Eidlitz, Albert S. DeVeau, P. M. Scribner, F. W. Wilkins, Martin A. Oberlander, Cyrus O. Baker, Charles W. Price, C. J. Purdy, E. W. Rothschild, F. W. Harrington, R. B. Corey, E. R. Knowles, W. H. Morton, secretary of the National Electrical Contractors' Association, J. E. Way, Albert Taylor, John H. Dale, George L. Patterson, F. M. Hawkins, A. P. Eckert, M. Loewenthal and E. B. Latham.

ECONOMICS OF TRANSMISSION PROBLEMS.[1]

ELECTRIC TRANSMISSION AS A PROBLEM OF ECONOMICS RATHER THAN OF ENGINEERING.

BY F. A. C. PERRINE.

The electrical transmission of energy is but a special case of transmission and transportation; of transmission when the distance is short, or transportation when it is long. For transmission it is analogous to the belt; for transportation to the coal train or pipe line.

While the electrical problems may be identical whether the transmission be long or short, the economical problems are totally different and the elements of greatest importance in short-distance transmission are only incidental advantages in long-distance problems.

In electrical transmission at short distances, we concern ourselves only with a comparison to mechanisms. Shafts, gears, belts, chains or wire ropes accomplish the same purpose and the decision is based upon the relative efficiency, with due consideration of the applicability of electricity to the machinery in question to which it is capable of applying a more uniform torque and in the operation of which it can affect economies, particularly when there is any question of intermittent operation.

These questions, while of importance to the proper solution of the long-distance problem, are nevertheless of relatively secondary interest, the fundamental question not being of the applicability but of the development and cost of transport.

The analogue and competition of long-distance transmission of energy are, therefore, the coal train and the pipe line, and the problem set squarely before us is whether it be cheaper to transform the energy of coal or water at the point of production and transmit it to the favorable factory site, or either by moving the factory to the power site make use of a water power or again locate the factory at a point advantageously located as regards a market and transport the fuel unconverted to be transferred at the factory into some useful form of energy.

Markets may be said to be in existence when, in the region to be served, sufficient factories or other plants are to be found capable of making full use of the energy to be developed. That such plants are in existence proves the availability of the territory for users of power, at the same time it points equally strongly to the fact that the region is one in which the source of energy already in use can be readily utilized in competition with other regions similarly situated as regards market for their produce and available workmen. In other words, a market already established is an indication that some competitive form of energy is strongly established and such territories may at the best be examined only with a view to competition and the possible revenue can only be estimated on a competitive standpoint. In such a region, the cost of the installation of a new form of drive to supersede that already in operation is a disadvantage to be overcome, and the advantage to the customer must be assured. Every advantage to be derived from the electrical drive is then important to consider as well as the price of energy per unit if a market is to be wrested from the competitor.

While it is important to secure a market which is thus ideal, it is not always true that such a market is readily accessible from the operating plant. It is true that electrical energy may be transported to considerable distances, but at the same time we must never lose sight of the fact that transmission to a distance greater than that equivalent to 100 kilowatts per mile is a transmission in which it is not easy to predict success and, in consequence, the nearer competitive market is often preferable to the market with a better possible price where the transmission is for a considerably greater distance.

The character of the market determines the possible revenue, and this in turn determines the limits of possible transmission or accessibility. Great distances of market has no terrors for the electrician perhaps, as he can plan the system at high voltage and with economical construction to permit delivery and satisfactory regulation, but, to the operating engineer, an entirely different problem is presented by distance. As distance increases, not only must new questions of voltage, inductance, capacity, switching and lighting protection be introduced, but every additional mile of separation between points of generation and distribution increases the difficulty of supervision and every mile of line increases the number of supports for the line, which not only vastly increases the difficulty of inspection but also increases the probability of accidental interruption.

At the present time each kilowatt of energy developed may be estimated conservatively as being equal to the use of twelve tons of coal per annum, and on this basis the water power compared with the coal mine. In making any such comparison it must, however, be remembered that while the value of the coal mine is constantly decreasing, as the coal is mined, the value of the water power is constantly increasing with the rising price of coal, and that, when the coal supply of the country is entirely exhausted, the water power will still be in operation with but slightly diminished volume.

The simple presence of an apparently invincible source of competition does not necessarily render the development of transmission plants, whether operated by water or coal, unprofitable ventures; though it does necessitate more than usually careful study of the character of the market and the adaptability of electricity as a form of energy to its needs. For certain industries and in certain localities the isolated plant, whether for the direct application of steam power or for the production of electricity for use on the premises, is an anomaly.

So far, we have considered the competitors of power transmission as arising solely from the character of supply and have not considered other means of the transmission or transportation of energy or its source. This brings us directly to the question as to whether it is not more advantageous to develop power at the coal mine or oil well for transmission electrically than it is to transport the coal or oil by means of a railroad or pipe line to the point of use to be used there as a means of generation. This is a new problem in electrical engineering. Much has been written against the feasibility of generating electricity at the location of the source of fuel and transmitting it to the market. The arguments so far have been almost invariably based upon the relative efficiency of the electrical transmission and the coal train. If we assume that a railroad is already built and that it is already being maintained by its present freight traffic, there is no question but what it would be difficult to figure out any increased economy or decreased cost of transportation of energy from coal by means of the transmission line. Furthermore, the alluring problem of the use of the waste from coal mine in the development of electrical power for transmission has been thoroughly condemned by those who have investigated it on account of the fact that in the present day the untransportable waste of coal mine is too small to be considered as a fuel for a transmission plant of any importance. There are, however, many locations in the country where fuel is obtainable which are not readily connected with a manu-

[1] Abstract of a lecture delivered recently before the Brooklyn Polytechnic Institute, Brooklyn, N. Y.

facturing market by satisfactory transportation routes.

In these locations are included not only the undeveloped mines in remote mountainous locations, but more particularly the mines which are surrounded or those owned or operated by coal-carrying roads themselves or by companies allied to these roads. The present condition of the independent miner, particularly in the anthracite coal field, is a non-competitive position. He is only capable of mining for a market in excess of that for which the companies controlling the territory wish to mine from their own properties and his only customer possible to him is the coal road or the coal company with which he is supposed to be in competition. In consequence, he must either take the price they offer him or leave his coal unmined and unsold.

Electrical generation and transmission is a means, under such circumstances, of finding an independent market for the product of the mine, and when such a plan is carried out, it is the equivalent for a miner of an independent road of his own. It may be objected that such a miner is not, even at his delivery point, free from the same competition that he finds about the mine itself, and while this is apparently axiomatic, it is at the same time true that at the delivery point the possible price of coal is determined by other circumstances than those which surround the mine, and in dealing directly with the customer for power the owner of the mine will find many conditions in his favor which are absent in the location from which the coal has been originally obtained. This problem is one for the immediate future. No such undertakings have as yet been attempted, but with the increasing use and advantage of electrical application, the probability of such a plan being carried out and the strong possibility of its commercial success is every day approaching nearer and nearer.

Automobile Freight Line between Lima and Callao.

A report from United States Consul A. L. M. Gottschalk, Callao, Peru, states that an automobile line has just been put into service between Lima and Callao, for the purpose of hauling freight between the two towns. The company has been formed by substantial business men, and has a capital of over $200,000. There are five automobiles in use at the present time, each having a carrying capacity of five metric tons. They carry the freight directly from the Callao docks to the warehouses in the city of Lima.

AUSTRALIAN TRAMWAY SYSTEMS.

BY JOHN PLUMMER.

In no part of the world, in proportion to the density of population, are street tramways more extensively used as a means of passenger transit than in the leading Australian state capitals. Although their introduction is of comparatively recent date, their development has been marvelous, and, as in many European and American cities, they have assisted in making riding cheaper than walking, and are causing the omnibuses and other conveyances of a past generation to become forgotten.

In Sydney the tramways were originally worker by steam power, the cars being double-decked, like the railway carriages on several of the Paris suburban lines, but subsequently the cable system was introduced, and later on electricity became utilized as the motive power, and with such success that it is only a question of time when the locomotive and cable will be found dispensed with.

The various tram-lines, which, like the railways, are the property of the state, form a complete network of communication between nearly every part of Sydney and its suburbs, thus assisting in counteracting the tendency to overcrowding which forms one of the evils associated with large centres of population.

The total length of tram-lines open on June 30, 1903, was 124.5 miles, representing an expenditure of £3,371,587 for construction and equipment, the number of passengers carried during 1903 being 130,405,402.

The Melbourne system, embracing a length of forty-eight miles, forty-three and one-half miles of which are worked by cable, and four and one-half miles by horses, was constructed by a municipal trust at a cost of £1,705,794, and is leased to a company. It is said to be the largest and best cable system in existence. The number of passengers carried during the year was 47,564,942.

There are also several suburban lines worked by limited liability companies as follows—horse eight and one-half miles, electricity four miles, and cable two and one-quarter miles. In Brisbane the tram-lines were originally worked by horses, but in 1897 they were replaced by electricity, the tramways being the property of an English company, and covering a total length of twenty-eight miles. As the traffic increases, extensions are effected.

At the close of 1902 there were in the state sixty-five miles of tramways, including those in Brisbane, the number of passengers carried during 1903 being 18,125,302. In Adelaide there are several tramway lines worked by horses, but an attempt is being made to secure the introduction of the electric system. The lines are owned by private companies.

In Western Australia, Perth has a well-organized system of electric tramways, which, like that in the Kalgoorlie municipalities, is the property of a private company. Fremantle and Boulder City also will shortly be in possession of electric tramway systems, constructed by private enterprise under municipal supervision. The only state-owned tramway is that running between the port of Roebourne and the town of Cossack, a distance of eight and one-half miles, in the northwestern portion of the state.

In Tasmania the Hobart tramways are worked by electricity, and extend a distance of about nine mines. They are owned by a private company, and were opened in 1901, in which year they carried 1,432,176 passengers. There is also a steam tramway in the northwest portion of the state, connecting Zeehan with Williamsford, a distance of eleven miles, its summit being 1,500 feet above sea level.

Compared with other Australian tramway systems, that of Sydney is considerably the most efficient, there being a continuous succession of trams from early morning until midnight, an all-night service being established on several lines. During the earlier hours of the day and in the evening the tram traffic is enormous, the cars, running almost every minute, being densely crowded. It is the same at holiday time, and the greater the amount of accommodation provided by the state railway commissioners the denser becomes the crowding. It is as if the whole population desired the use of the tram-cars. Yet, with all this heavy traffic, accidents are comparatively few, being in most instances due to the disregard of ordinary precautions on the part of the sufferers.

All the Australian electric systems are on the overhead wire principle, which is not found to interfere with the work of fire-brigades to anything like the extent originally anticipated. The cost of the New South Wales tramways was defrayed out of loan revenue, and they constitute one of the most valuable assets of the state.

The Schenectady (N. Y.) Home Telephone Company has installed two street telephones in that city. In addition to being public pay stations they are for police and fire service.

Reviews of Current Engineering and Scientific Literature.

The Cadmium Amalgam Lamp.

An attempt to improve the color of the light emitted by the mercury vapor lamp is here described by M. A. Bainville, who quotes from a German contemporary. The lamp consists of a H-shaped bulb with the horizontal member somewhat elongated. The lower parts of the two end members are filled with an amalgam of mercury and cadmium. To these terminals are attached two glass tubes, which are turned through two right angles. In the horizontal portion of each of these tubes a glass plug is fused, through which an iridium wire is passed. These plugs form the first seals of the lamp. Beyond them, in the vertical portion of the tubes, mercury is placed, and into this two iron wires are inserted, which are then sealed in by means of shellac. The tube is thoroughly exhausted, and is started as is the ordinary mercury vapor lamp. The amalgam is soft at ordinary temperatures, but becomes liquid when heated. It consists of fourteen parts of cadmium to 100 parts of mercury. The light contains, in addition to the mercury rays, those of cadmium. It burns quietly, but there is a tendency for it to lose its vacuum. This gives it a short life. When this condition has been reached, the lamp can only be started after having been heated. The lamp can be restored to its original condition by reexhausting.—*Translated and abstracted from L'Électricien (Paris), February* 11.

A Universal Projection Lantern.

A conveniently arranged projection lantern, designed by Dr. M. T. Edelmann, is here described. The lantern proper is mounted on a tilting shelf, attached by short legs and hinges to a table. The table itself is carried on a triangular pedestal, made large so as to be rigid, and enclosing the regulating resistance. This pedestal is, in turn, carried on a tripod, two of the legs of which are mounted on casters, and the third has rollers which do not swivel. These rollers and a bolt attached to one of the other legs hold the lantern firmly in a fixed position. The lantern may be supplied either with a hand-regulated or automatic arc lamp. It has the usual complement of lenses, a water cell, and a system of mirrors which enables the horizontal ray to be thrown vertically and then again horizontally in any direction. The lantern has a convenient arrangement of rods attached to the upper part, which is swung back when not in use, and which may be used as a support for certain attachments. For lecture purposes, a set of skeleton instruments is supplied. One of these is a vertical conductor, to which is attached a skeleton hand and a magnet for demonstrating the relation between the direction of current flow and magnetic flux. The essential parts of an electric bell, mounted on a sheet of glass, demonstrate the operation of the device, while ammeters and voltmeters of different types, and mounted in a similar way, may be placed directly in the beam of light and an image thrown on the screen, enabling readings to be observed by the entire audience.—*Translated and abstracted from the Physikalische Zeitschrift (Leipsic), February* 1.

Some Tests Conducted with an Electrolytic Rectifier and Motor-Generator.

Having occasion recently to specify apparatus for charging an electric automobile, Mr. Horace Boot tested two types of apparatus for this purpose. The first was a motor-generator set, the dynamo having an output of fifty amperes at 120 volts. It was driven by a twelve-horsepower motor. The efficiency of the set was found to be only 49.1 per cent. The cost of the equipment was $775. The low efficiency seems to have been due to poor electrical design, for the mechanical losses were small. Thinking that an electrolytic rectifier would be cheaper and, at the same time, more efficient than the motor-generator set, a Nodon rectifier with a similar direct-current output was tested. This device consists of four lead cells filled with a saturated solution of ammonium phosphate. The cells are arranged according to the Gratz method, so as to rectify both halves of the current wave. Tests of this device showed an efficiency of sixty-five per cent. The cost of the complete installation was $340. The electrodes are twelve inches long, six inches deep, and one-eighth of an inch thick, and consist of an alloy of zinc and aluminum. This device gave no trouble whatever as long as the temperature did not exceed 120 degrees Fahrenheit. To prevent this occurring, a small fan is mounted at the side of the case, so as to force a draught of air through the device. The efficiency is well maintained up to this temperature, but beyond that begins to fall rapidly. As the device is constructed there is said to be no danger of an excessive temperature rise. The size overall, of the case, is three feet nine inches by two feet four inches by four feet ten inches high.—*Abstracted from the Electrical Review (London), February* 10.

Measurement of High Temperatures in the Electric Laboratory.

An easily constructed pyrometer is here described by M. Georges Rosset. The author first discusses the usefulness of the ordinary forms of pyrometer, and lays stress upon the necessity of determining accurately high temperatures which are so frequently used in research and in industrial laboratories. Those who can not afford the commercial instruments may construct a simple and cheap, but reliable, pyrometer, in the following way: the couple is made of a platinum wire and a ten per cent platinum-rhodium wire. The two wires are soldered together and enclosed in any convenient form of protecting tube. For measuring temperatures, a sensitive galvanometer is desirable, but, when this is not available, a millivoltmeter may be employed with sufficient accuracy. To calibrate the instrument, the following temperatures are useful:

	Degrees C.
Water boils	100
Naphthaline boils	218
Zinc melts	420
Sulphur melts	445
Aluminum melts	655
Sodium chloride melts	800
Zinc boils	930
Gold melts	1,065
Copper melts	1,085
Platinum melts	1,780

The reading for the latter temperature is obtained when soldering the couple together. Plotting the galvanometer deflections and temperatures on rectangular coordinates, practically a straight line is obtained, which allows the temperature for any deflection to be interpolated readily. It should be noted that every individual couple must be calibrated, and the process must be repeated every time the solder of the couple is melted or broken. If the platinum and platinum-rhodium wires are not available, other

materials which are to be found in every laboratory may be employed. Iron, German silver, nickel, or nickel-steel wires, which are commonly used for constructing resistances, give fairly high thermoelectric forces, and may be used in constructing fairly satisfactory pyrometers.—*Translated and abstracted from Centralblatt für Accumulatoren (Gross-Lichterfelde-West), February* 1.

The Arc in a Magnetic Field.

An investigation of the effect of a magnetic field upon the Voltaic arc has been carried out by Mr. C. D. Child, who here gives the results of his study. The first experiment consisted in placing two carbon pencils at diametrically opposite points of the arc, so that the effect of the magnet is to blow the arc out toward one pencil. To measure the effect, a millivoltmeter was used, and readings indicating a difference of potential of approximately three volts were obtained. Measurements with an electrometer gave approximately the same results. To test whether the effect was due to unsuspected causes, measurements were made between the carbons of the arc and the carbon pencils. The results agreed with those previously obtained. It should be said that that pencil toward which the arc is deflected becomes positively charged. To eliminate effects due to the varying voltage of the arc itself, a commutator was arranged, which rapidly reversed the direction of current through the arc and the voltmeter. A deflection of the millivoltmeter was obtained, agreeing with the first readings. To test whether the effect was due to the magnetic action or to the mechanical displacement of the arc, the latter was blown to one side by means of a current of air. In this case readings were obtained on the voltmeter or the electrometer, but they were uncertain both in direction and in amount. The effect in this case seems to be due to the difference in temperature of the two carbon pencils. In another arrangement an oscillating fan was placed so as to blow the arc alternately in two directions. The voltmeter connections were changed at the same time. No deflection of the voltmeter was observed. Varying the rapidity with which the current through the arc was reversed produced but little effect on the deflection of the voltmeter, and this may be attributed to the inductance of the electromagnet and the voltmeter. Exploring the field around the arc by means of the pencils gave uncertain results. In this case the carbons were unequally heated. The current through the arc was varied from five to twenty-five amperes without obtaining any change in the difference of potential between the two supporting pencils. Changing the length of arc, however, did change the results, for with a length of arc of three millimetres, the current being twelve amperes, the potential difference between the pencils was 1.7 volts. When the length of the arc was nine millimetres, the difference of potential between the pencils had risen to three volts. When the strength of the magnetic field was varied by varying the distance of the solenoid from the arc, the difference of potential between the pencils varied with the field. The effect depends largely upon the kind of carbon used: when salts are added to the carbon it is greatly reduced, and may even disappear entirely. The effect took place with the arc in a vacuum. The difference of potential between the pencils decreased with decreasing pressure of the gas. The common equation for the Hall effect does not apply to this phenomenon, since there is here a motion of the ions traverse to the direction of the impressed electromotive force. The effect may be explained by assuming that the positive ions move more rapidly than the negative ions.—*Abstracted from the Physical Review (Lancaster), February.*

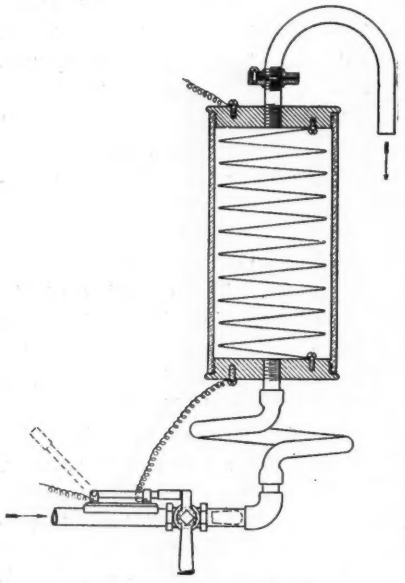
The Mercury Arc.

A brief summary is here given by M. D. de Valbreuze of the principal results obtained from the application of the electric arc in mercury vapor. The most important application is that of lighting, and the different types of lamps are described and criticised. The most satisfactory method of starting is held to be that in which a short-circuit is produced by means of a thin column of mercury which flows from one electrode to the other. When this breaks, the arc is started. When this method is used, precaution must be taken to prevent the breaking of the tube, due to the shock of the mercury. This is done by inserting in the bulbs bundles of iron wires, which break up the mercury and prevent a shock. The author thinks that the life of these lamps will be less than that which is usually given, for it is impossible to drive off all the occluded gases from either the iron electrode or the mercury. The purest mercury obtainable should be used. The condensing chamber of the lamps should be large, so as to maintain the current steady. The objection to the color has not been overcome, as no satisfactory method of adding the needed red rays has been found. Attempts to add other metals to the mercury have failed; nor have endeavors to make use of fluorescence had any better result. Neglecting the objection to the color, the light is held to be very satisfactory and very easy on the eyes. The lamp has high actinic value, and thus can be employed in therapeutics. In this case it is desirable to make the enclosing-vessel of quartz. The high-frequency mercury-vapor interrupter has not yet been applied in practice, but the use of the mercury-vapor arc as a simple interrupter for alternating currents promises well, though its application will be limited to small currents. No actual instance of such use is known to the author. The operation of the mercury-vapor rectifier is explained. It is usual to attribute this action to the dissymmetry of the electrode, but M. de Valbreuze holds that this is not correct, for a rectifier may be made in which all the electrodes are formed of mercury. It is held that when an arc is once started through mercury vapor, it tends to persist in the same direction, and current can not pass through in the opposite direction unless a fresh start is made. With an alternating current between electrodes of carbon, the current may flow in either direction after its passage through zero, because the electrodes are maintained at a temperature high enough for the emission of negative electrons from the cathode. On the contrary, with electrodes of mercury the temperature is uniformly in the neighborhood of 150 degrees after the passage of the current through zero, although the temperature at the base of the arc must have been sufficient to raise the mercury to yellow or white incandescence. In order that the current may flow in the opposite direction after having changed sign, the electrode must be in such a state that the arc can pass without a fresh starting. While the dissymmetry of the electrodes contributes some, the other effect is the principal one. The great difficulty in the general use of this apparatus is that of preventing an increase in the temperature of the rectifier, and a consequent increase in pressure in the interior of the globe.—*Translated and abstracted from L'Eclairage Électrique (Paris), January* 28.

The production of Lake Copper in January is returned at 18,483,880 pounds. Of this amount the Calumet & Hecla has to its credit 6,800,000 pounds, and the balance came from seventeen other mines. —*Copper Gossip.*

Electrical Patents.

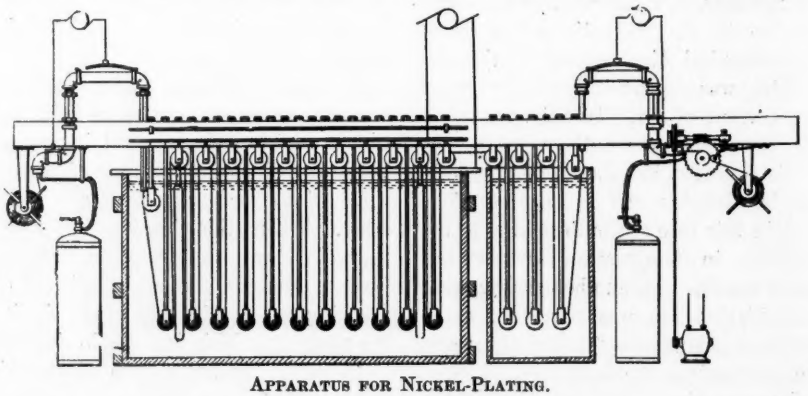
An electrical water heater has been recently patented by Milton H. Shoenberg, of San Francisco, Cal., and assigned to the Shoenberg Electric Appliance Company, of the same place (782,525, February 14, 1905). The invention consists of an insulating heating chamber



ELECTRICAL WATER HEATER.

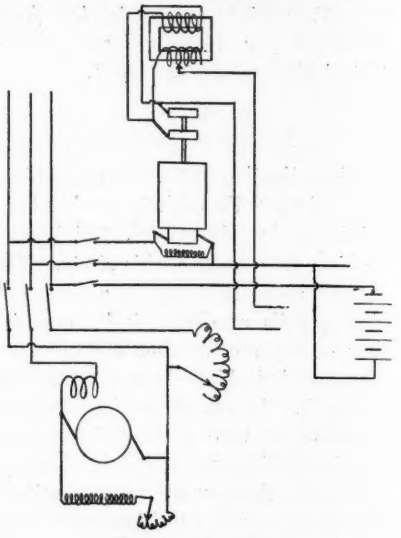
having supply and discharge passages at opposite ends, and an electrical conductor located within the chamber and immersed in the liquid to be heated. In carrying out the invention, an electrical water heater is provided and an insulated chamber through which an electrical resistance coil extends. Conducting wires are employed by which an electric circuit may be established through the coil. A controlling switch is provided for the circuit. Connecting with opposite ends of the chamber are insulated water supply and discharge pipes, the water supply being controlled by a cock or faucet. A switch member is in the electric circuit and is movable into and out of the range of action of the faucet, whereby the faucet is prevented from closing while the electrical switch is closed.

An apparatus for nickel-plating has been recently devised and patented by Jonas W. Aylsworth, of East Orange, N. J., and assigned to the Edison Storage Battery Company, of Orange, N. J. (781,867, February 7, 1905). The invention relates to improved apparatus for nickel-plating after the manner of the process described in the patent to Thomas A. Edison, No. 734,522, of July 28, 1903, wherein the nickel film electrolytically deposited on the iron or steel surface is welded thereto by heat in a non-oxidizing atmosphere, whereby the plated coating is relieved of any condition of tension and is practically homogeneously united to the sheet, plate, or other article. The object of the invention is to provide an apparatus which will permit such a process to be carried on continuously, the article or articles being electroplated and the deposited coating being subsequently welded by successive automatic operations, whereby previously nickel-plated articles will be subjected to the welding operation simultaneously with the plating of successive portions of the same article or successive articles. Improved facilities are also provided for automatically washing the plated articles subsequently to the plating and previous to the heating thereof, and it also provides improved means for treating the articles previous to the plating so as to remove any film of oxide or grease, which would interfere with or reduce the character of the deposited coating. Means are also employed for electrically heating the articles for the purpose of welding the deposited coating thereon, although the heat may be applied in other ways. The deoxidizing or cleaning of the articles can also be effected by electrically heating them in a reduced atmosphere. The apparatus comprises a heating chamber containing a reducing atmosphere through which the strip passes. Means are provided for heating the strip therein so as to deoxidize the same, also means for maintaining a reducing atmosphere in the heating chamber. A plating bath is employed in which is arranged a series of pulleys over which the strip runs. A second heating chamber welds the plated coating on the strip and pulleys are located in this second heating chamber, over which the strip runs. Means are provided for heating the strip in the second heating chamber and also means are employed for maintaining a non-oxidizing atmosphere therein.



APPARATUS FOR NICKEL-PLATING.

An electric system having particular relation to alternating and direct-current systems which may be used for train lighting or other purposes has been devised and patented by Horace Dowie, of Brooklyn, N. Y. (203,828, February 14, 1905). In this system there are employed



ELECTRIC SYSTEM.

an alternating-current circuit and a direct-current circuit of normally higher potential. A solenoid is connected to the alternating-current circuit. An automatic throw-over switch comprises movable contacts permanently connected with fixed contacts. A storage battery is connected to the contacts cooperating with the movable blades of the throw-over switch and connected with the direct-current circuit, this battery comprising a charging circuit having a battery cut-out and connected with the control switch. The throw-over switch comprises a solenoid energized through the control switch and throwing the load into connection with the alternating-current circuit when the circuit is properly energized. The control switch is normally drawn into contact to throw the load into connection with the direct-current circuit and the storage battery when the alternating-current circuit is not properly energized.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Best Manufacturing Company's Valves.

The Best Manufacturing Company, Pittsburg, Pa., makes a number of steam specialties which are shown in the accompanying illustrations. In Fig. 1 is shown the Best patented, adjustable, wedge gate valve.

The adjustable wedge is of the same form as the solid taper wedge, except that it is in two parts, there being a ball joint on the inner surfaces around the entire circumferences of the wedges, thus ensuring a positive seating and being at all

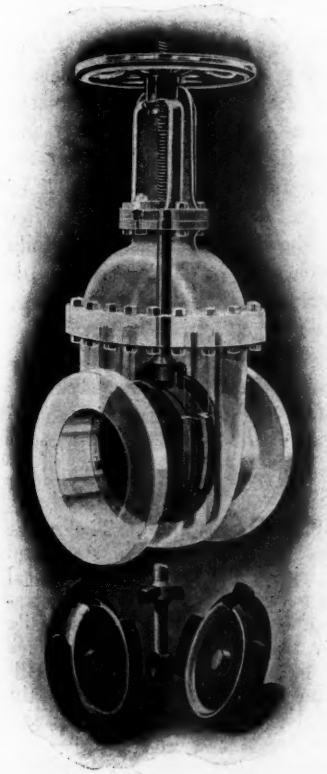


FIG. 1.—BEST ADJUSTABLE WEDGE GATE VALVE.

times absolutely adjustable. This also ensures the taking up of the wear, the renewable feature making the valve very durable. There are rails or guides cast in the body on either side, and wings cast on either side of the wedges which fit inside of the guides or rails in the body; this absolutely prevents any possibility of the valve becoming disarranged. It will also be noted that there are wings cast on the top edge of the wedges, and also a collar with guides, cast on the spindle. The Best adjustable wedge gate valves are so constructed that they have no more parts than a solid taper wedge gate. The wedges have bronze facings and the bronze seats are screwed up in such a manner as to leave no pockets in the rear for the

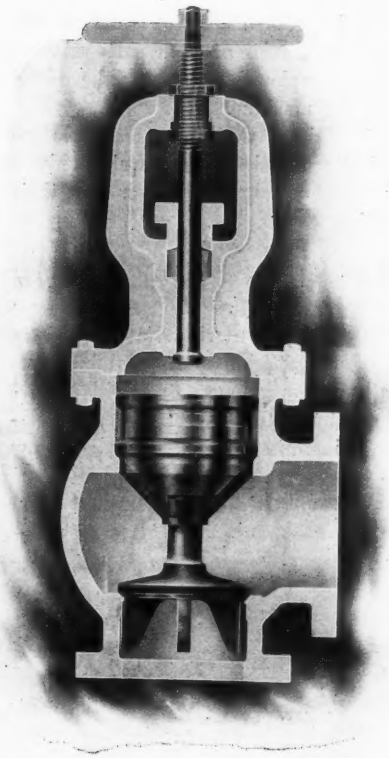


FIG. 2.—ANDERSON CUSHIONED NON-RETURN VALVE.

water and steam to attack the threads. The method of seat construction avoids some of the alleged bad features of gate valves. The correct mechanical construction of these valves makes them especially fitted for all classes of service, and particularly high pressure and superheated steam service.

The Anderson cushioned non-return

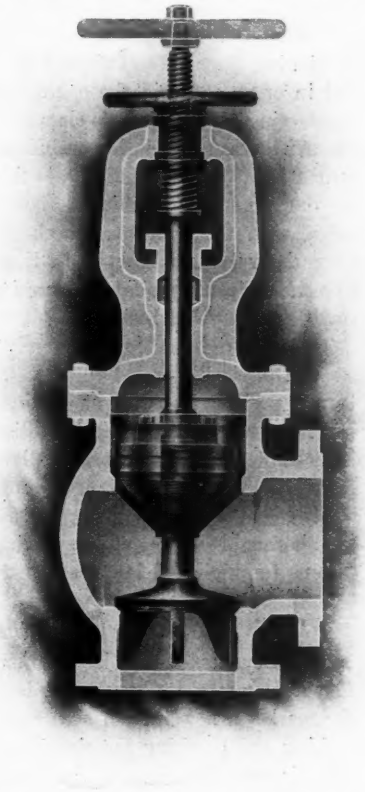


FIG. 3.—ANDERSON COMBINATION CUSHIONED NON-RETURN VALVE.

valve is shown in Fig. 2. This valve, when placed between the boiler and header, will equalize the pressure between the different units of a battery of boilers. They remain closed as long as the boiler pressure is lower than that of the header. When

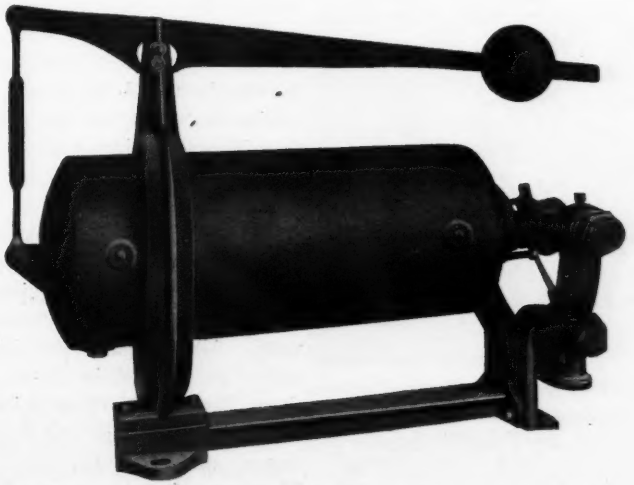


FIG. 4.—BEST HIGH AND LOW PRESSURE TILTING STEAM TRAP.

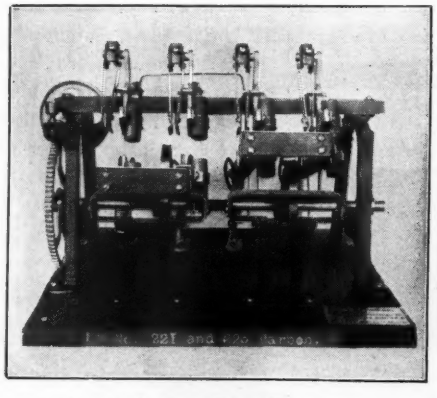
the boiler pressure equals the header pressure, they open and will remain in that position without chattering or hammering. They will automatically cut off a boiler in case of accident to the boiler, such as the bursting of a tube, and will also act as a safety stop to prevent steam being turned into a cold boiler while men are working inside. The cut shows plainly the perfect dash-pot arrangement for cushioning these valves, which is so essential in order to avoid the chattering and hammering existing in this class of valves. The Anderson combination cushioned non-return valve, shown in Fig. 3, is the same as the Anderson cushioned non-return valve, with the additional mechanism to open the valve and hold it in that position if desired by simply operating the small auxiliary hand-wheel.

The Best high and low-pressure, tilting, steam trap is illustrated in Fig. 4. The trap is positive in action at all times and can not get out of order. The discharge is prompt, speedy and practically noiseless. All working parts are bronze and easily removed when necessary. The traps are thoroughly tested under varying conditions for high and low pressures.

Dull's Carbon Type Flasher.

The Reynolds-Dull Flasher Company, 177 Adams street, Chicago, is placing on the market a new type of sign flasher for making and breaking the circuits of electric displays and signs. The illustration herewith shows a machine of the two-circuit size, but the flashers can be furnished in sizes from one to six circuits for either two or three-wire systems.

For handling heavy currents it is



DULL'S CARBON TYPE FLASHER.

claimed that this flasher possesses marked advantages as the "make" and "break" of the circuits fall on carbon points which are less susceptible to injury by the arc than is the case with metal contacts.

Standard five-eighths-inch light carbons are used, which by the action of the flashers are subsequently relieved by metallic contacts. These contacts receive the load without arching and on the break are first released. The carbon finally breaks the circuit and all burning incidental to the arc falls on the carbon contacts. The use of auxiliary metallic contacts prevents heating of the carbons and reduces their deterioration.

This improvement is of value as the natural properties of both sides of contacts are employed to prolong the useful life of the machine.

It is claimed that these machines are practically noiseless and require only a very small amount of power for their operation.

Portable Electrically Driven Grinders and Drills.

The accompanying illustrations show a few of the specialties in portable electrically driven grinders and drills manufactured by the Hisey-Wolf Machine Company, Cincinnati, Ohio. This company

FIG. 1.—PORTABLE ELECTRICALLY DRIVEN GRINDER.

devotes its entire attention to the building and perfecting of this form of apparatus. The company makes its own motors, and also all parts pertaining to the apparatus. Each machine is thoroughly tested by actual use before leaving the shops, and the company feels that it can guarantee the apparatus in every way.

Fig. 1 shows a portable electrically driven grinder. The standard motor grinders are wound for 110 and 220 volts, direct current. When required, however, they may be wound for from 70 to 250 volts. All the parts pertaining to the motor are encased in the shell, making them dust-proof. The spindle carries taper cone bushings running in three-degree and forty-five-degree bearings. They are adjustable to wear by means of a nut on the rear end of the spindle, and are provided with dust-proof caps.

The V-slide has a three-inch travel by means of a worm through the handle and is fitted with a gib to take up the wear. The shank is of steel, and is fitted to the hole in the V-cap. It is held in position with a screw so that different sizes of shanks may be used. An extension mandrel is used for internal

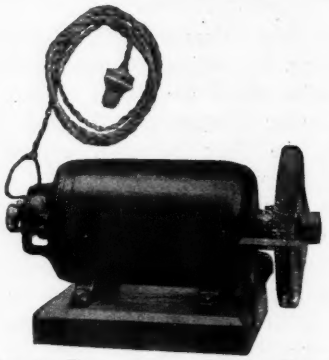


FIG. 2.—ELECTRICALLY DRIVEN BENCH GRINDER.

grinding by removing the regular wheel and attaching the mandrel in its place. The tooth rest is a valuable attachment, serving as an index for cutter and reamer grinding. Power is secured for this grinder from any incandescent light socket.

Fig. 2 shows a portable electrically driven bench grinder. This may be utilized for grinding, buffing and polishing, as the emery wheel can be removed, and any other wheel substituted. This apparatus is made in three sizes—styles E, F and M. One wheel and detachable wheel rest are included with each machine.

Fig. 3 shows a portable electrically driven hand or breast drill. The motor is provided with a switch to start and stop the drill, located near the vertical handle, as may be seen from the illustration. In operation, the switch is easily reached by the index finger. The chuck spindle is so arranged as to allow drilling on the line with the base of the motor, by this means permitting angle and corner drilling.

The motor is enclosed, and suitably

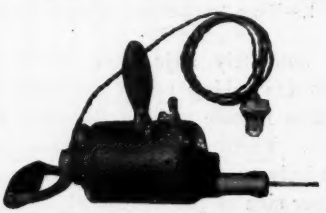


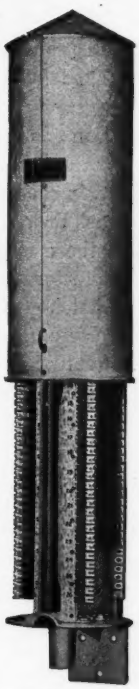
FIG. 3.—ELECTRICALLY DRIVEN BREAST DRILL.

geared to develop the necessary power up to the capacity of the drill. Being light in weight, the apparatus may be carried anywhere, and the operation is only limited by the length of cord which may be employed.

Archibald B. Rush, 120 Liberty street, New York city, is eastern representative of the manufacturer.

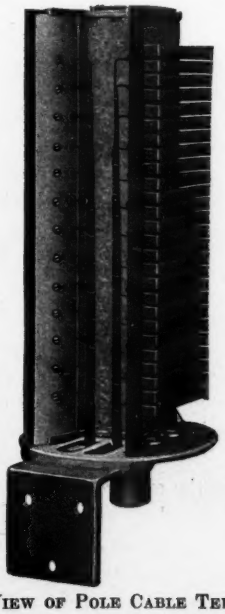
Pole Cable Terminals.

Frank B. Cook, 249 West Lake street, Chicago, Ill., has made a number of radical improvements in his pole cable terminals. His type S. A. terminal is a



POLE CABLE TERMINAL WITH COVER.

combination of the tubular line fuse and carbon lightning arrester, mounted upon a galvanized sheet cable box. This is provided with a bracket so that the terminal



REAR VIEW OF POLE CABLE TERMINAL.

can either be attached to the cable pole or cross-arm. A sliding galvanized cover thoroughly protects all parts from the weather. A heavy cast-iron box was originally used for these terminals, but the sheet metal box now used reduces the weight considerably and makes connections easier of access.

The type T. A. terminal is for use exclusively with potheads. It is of the same size and exterior appearance as the type S. A. There is a difference in mounting, however, as hard maple strips are employed in place of the sheet-metal cable box, the tubular fuses and carbon lightning arresters being mounted on these strips. The strips are rigidly attached to the bracket.

With either of these terminals it is not necessary to use a pole house or balcony. The galvanized metal cover stays up when it is raised, and when it is pulled down it locks automatically. The manufacturer states that these terminals are absolutely weatherproof and combine ease of access with efficiency and simplicity. Being constructed of metal, they will not burn. The springs which hold the tubular fuses are so arranged that it is impossible for a man to leave a loose connection. The terminals will go between the wires if desired, and it is unnecessary to move the wires or the guys.

Los Angeles-Pacific Railroad.

Owing to the greatly increased traffic on the interurban railway system of the Los Angeles-Pacific Railroad Company, the officers of that company have decided to increase the capacity of their central power-house at Vineyard and to install an additional substation in Los Angeles. The new electrical equipment has recently been contracted for with the Crocker-Wheeler Company, Ampere, N. J., through its Pacific coast managers, the Abner Doble Company, of San Francisco. The contract comprises one 1,200-kilowatt, three-phase, fifty-cycle, 2,300-volt, engine-type generator with a speed of 125 revolutions per minute; one 300-kilowatt motor-generator set; one 400-kilowatt motor-generator set; three 400-kilowatt transformers; three 160-kilowatt transformers; three 120-kilowatt transformers, and a sixty-kilowatt engine-type exciter. The 1,200-kilowatt alternator will be of the Crocker-Wheeler Company's new revolving-field type, similar in construction to the three 4,000-kilowatt alternators recently ordered by the California Gas and Electric Corporation. The Los Angeles generator will be driven by a 2,000-horse-power compound, condensing McIntosh & Seymour engine. The motor-generator sets will consist of 2,300-volt synchronous motors driving 600-volt direct-current railway generators. The transformers will be built for 15,000 volts on the primary and 2,300 volts on the secondary and will be of the new water-cooled and oil-insulated type recently brought out by the Crocker-Wheeler Company.

The interurban railway system of the Los Angeles-Pacific Railroad Company is one of the most extensive in the country, embracing nearly 200 miles of up-to-date lines. The company owes its growth largely to the energetic and untiring work of the president and manager, Mr. E. P. Clark, who was one of the pioneer railway men of Southern California and who has seen his system develop from a very small beginning to its present commanding position in the traction field. The system extends from Los Angeles in a fan-shape to Santa Monica, Ocean Park, Playa del Rey, Hermosa, Manhattan Beach, and Rodondo on the ocean, and passes through the intermediate towns of Hollywood, Colegrove, Sawtelle, Sherman and Palms. In other words, the lines cover thoroughly the territory lying south of the Santa Monica mountains and between Los Angeles and the ocean. Most of the lines have been double-tracked and are constructed in conformity with the best steam railroad practice. About a year ago a new central steam plant was installed at Vineyard about five miles west of Los Angeles and from this station transmission lines at 15,000 volts carry the power to several substations located at intervals over the system.

An Automatic System of Refrigeration.

The Federal Automatic Refrigerating Company, 22 Thames street, New York city, manufactures and installs complete automatic refrigerating plants from one horse-power to ten horse-power capacity, or the equivalent of 800 to 1,200 pounds of ice refrigeration per day. The automatic system developed by this company is mechanical and purely automatic. Any desired low temperature, even to zero Fahrenheit, may be uniformly maintained in a properly constructed refrigerator or compartment. The machine and all automatic devices are controlled or regulated solely by the temperature required in the refrigerator. A special thermostat absolutely controls the operation of the motor-driven compressor. All other automatic devices are, in turn, dependent upon and regulated by the compressor in operation.

The compressor can be operated either by an electric motor, a steam, gas or oil engine, or may be belted to a countershaft. Any existing plant can be made automatic in its operation by introducing the several automatic devices and regulators manufactured by this company.

The officers of the Federal Automatic Refrigerating Company are A. M. Young, president; A. C. Dunham, vice-president; F. M. Kimball, secretary and treasurer, and J. C. Chamberlain, general manager.

Closing Bulkhead Doors by Electricity.

The Long Arm System Company, Cleveland, Ohio, has developed a system for electrically closing the doors in the water-tight bulkheads in naval vessels.

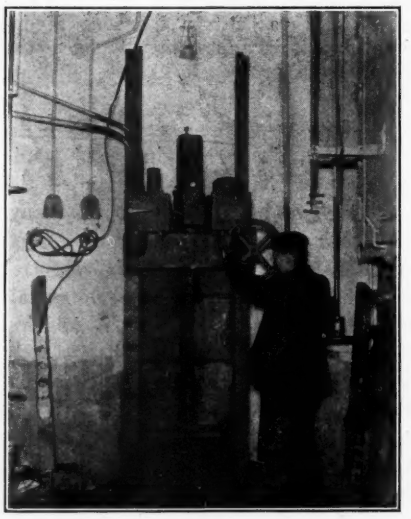
After several years of costly experimentation with pneumatic and hydraulic systems for operating bulkhead doors and armored hatches aboard warships, both systems have been abandoned by the American navy in favor of an electrical system. The first electrical installations are now in working order on the new 13,500-ton armored cruisers Colorado and Pennsylvania. Thirteen other cruisers and battleships now building will be similarly equipped.

The defects developed in the hydraulic and pneumatic systems—due mainly to the practical impossibility of keeping their valves and packings in working order—have been overcome in the electric system, and naval authorities, including many who have heretofore opposed, as necessarily ineffective, all power doors for bulkheads, have given the new "Long Arm" electrical system unqualified approval. The bad repute into which distantly controlled bulkhead doors fell at one time was brought about by the members of the crew who were likely to suffer from the operation of the power system. The first idea was to drop the heavy doors like so many guillotines; then followed the idea of closing doors slowly by air or water pressure. But in both cases it was found that the doors could not be depended upon to shut at the right moment, nor to stay open when so required, because the pneumatic and hydraulic pressure could not be perfectly maintained.

The electrical system, however, is not subject to these defects. It complies in every way with the specifications of the navy department providing that power doors or armor hatches "must be capable of permitting operation on the spot by power or by hand from either side of the bulkhead or deck," and "be capable of being closed by power simultaneously from an emergency station." It is further provided that when the doors are closed and the emergency is on, any door may be opened by a man at the door to allow him to pass through in performing his duties, but after he has passed through and released the controller handle the door will again close by the emergency action.

The mechanism of the "Long Arm" system may be outlined as follows:

1. An emergency station, located usually in the pilot house or some convenient place above the deck. 2. The power doors or hatch-gears, supplied with three independent mechanisms, namely, *a*, the switch by which a man at any door can open and close it at will from either side; *b*, the switch, operated from the emergency station, by which the door is closed upon the approach of danger. This emergency switch, although permitting absolute control, may have its operation suspended temporarily by the hand switch just mentioned. In such a case the emergency station switch will close the door as soon as the hand controller is released; *c*, the limit switch, by means of which the current supplying the motor which provides the power for closing and opening the doors, is cut off when the door has closed and locked, or has encountered an obstacle to full closure. This switch has mechanical connection with the door or hatch-plate and is so arranged that it will



TYPE OF VERTICAL DOOR OPERATED BY THE "LONG ARM" SYSTEM OF ELECTRICAL CONTROL, SHUTTING OFF COAL BUNKERS FROM THE ENGINE ROOM, U. S. ARMORED CRUISER COLORADO.

cut off the current from the motor, and thus prevent blowing out of the fuses. An interesting improvement of this part of the mechanism is one by which the switch is made to again close the circuit to the motor, and thus start the door toward its grooves after an obstruction is removed, *e. g.*, when an inflow of water washes away coal obstructing a bunker opening.

The door and hatch-gear motors are direct current, reversible, ironclad, bipolar, of light and compact construction for intermittent service. They are entirely enclosed in water-tight cases, and are capable of carrying large overloads without heating or injury.

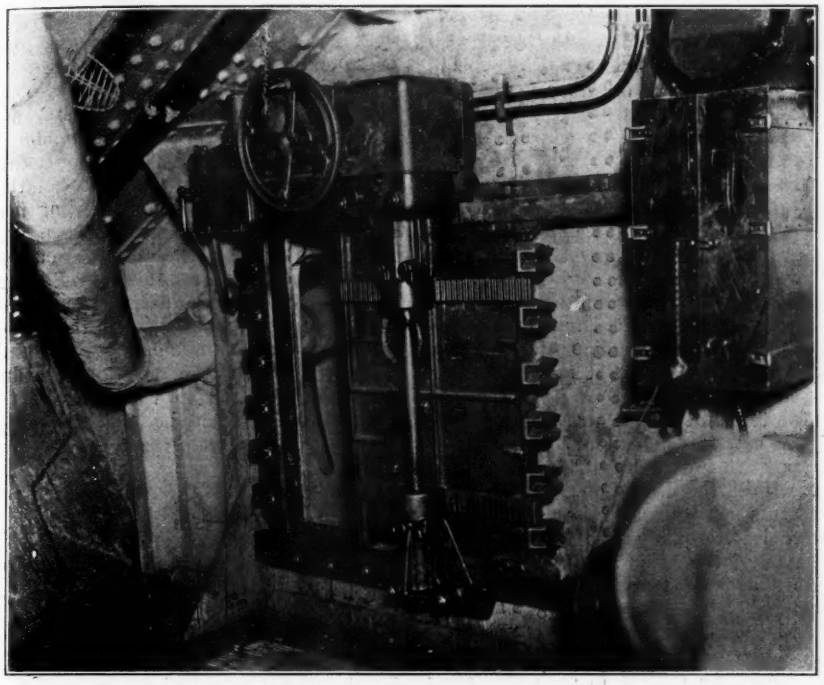
The emergency station consists of two parts, one a water-tight case containing the mechanism for controlling the circuit running to each door or hatch-gear for closing the same, and the lamps to indicate the closure; the other, a case containing the fuse box, in which each wire is supplied with the proper fuse.

The wiring required for a complete installation of the system is very simple. It comprises one twin conductor by which the emergency station is connected with the ship's mains; one twin conductor by which the controller on each door and hatch-gear is connected with the emergency station, and one twin conductor connecting the controller on each hatch-gear or door with the ship's mains. Here, as in other parts of the system, great simplification has been worked by replacing pneumatic and hydraulic power by electricity. The latter added another set of complicated machinery to the ship's equipment, while the electric system calls for nothing more complicated than connection with the electrical mains necessary for other purposes.

The operation of the "Long Arm" system is as follows: suppose that a vessel is in danger of being rammed, or that her hull has been punctured in some way. The officer of the deck or the one first aware of the danger will close the switch at the emergency station, immediately releasing the gearing driven by a spring and controlled by an adequate escapement. This gearing then closes the circuit for operating the emergency switch in the controller of each door or hatch-gear. It does not start all the motors at the same time, thus avoiding the necessity for a large supply of current. It starts the doors one after the other at intervals of about three seconds, so that twenty-five doors and hatch-gears can be closed in seventy-five seconds from each emergency station without more than six motors being in operation at any one time.

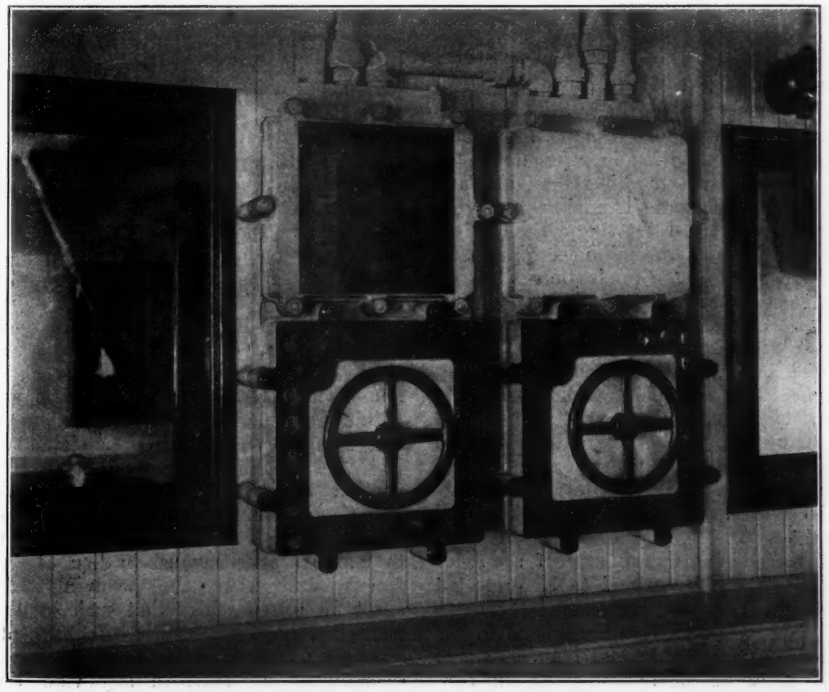
As each door makes a complete closure it automatically completes the circuit running to the emergency station and is there connected with a small incandescent lamp, located back of each of the discs around the edge of the emergency station. Each disc is numbered to correspond to a door, so that the officer in charge can tell by a glance at the station whether or not all the doors have closed. If any one door or hatch-plate has not closed the fact is immediately observed, and the location of the trouble is known by reference to a diagram at hand showing the location of all the power doors and hatchways.

Whether the emergency is "on" or "off" is indicated by a red light shining through one of the lower discs of the station.



HORIZONTAL BULKHEAD DOORS WITH ELECTRICAL CLOSING DEVICE, U. S. ARMORED CRUISER COLORADO.

The navy department has subjected this system to the severest possible tests before approving it. The results of these tests are shown in the fact that similar equipment is called for in the specifications for the last three of the men-of-war authorized by the United States government. The principal feature which has excited the approval of practical naval officers is that this device secures the confidence of the members of the crew stationed in the immediate vicinity of the power doors, the same men who had so little confidence in the hydraulic and pneumatic systems that they invariably tampered with the mechanism in such a way as to defeat its purpose completely.



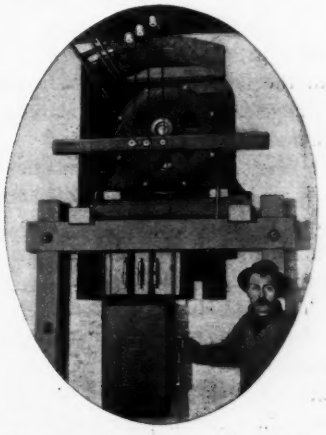
EMERGENCY STATION, "LONG ARM" SYSTEM, U. S. ARMORED CRUISER COLORADO.

The combination of perfect local control with the certainty which the electrical system gives that the doors will not suddenly drop, mainly accounts for this confidence.

The question of power doors is receiving attention by the admiralty departments of almost every important government in the world. The fact that H. M. S. Victoria might have been saved if her bulkhead doors had been closed has been ever in the minds of progressive naval constructors. Owing to the fact that nothing has been devised abroad better than clumsy imitations of the old hydraulic and pneumatic installations on American warships, now discarded by the American navy itself, accounts for the fact that foreign navies have not yet seen fit to call for power doors in the equipment of their new ships. It is likely, however, that several European battleships will be equipped with the "Long Arm" apparatus within a short time.

Induction Motor in a Tannery.

It is well known that the electric motor requires so little space, care and maintenance that it may be installed in very crowded and inaccessible quarters. These characteristics in which the electric motor compares so favorably with other forms of motive power are often important considerations leading to the selection of electric drive.



INDUCTION MOTOR IN A TANNERY.

Available space is seldom as scarce, however, as in the case of the Zeller tannery, at Buffalo, N. Y. In this installation, also, the spattering and slopping of the tanning liquor require that the motor be placed well out of the way of the tanning processes. The problem was solved by taking out a window in a brick partition and installing a forty-horse-power, twenty-five-cycle, 750 revolutions per minute, three-phase General Electric induction motor on a wood framework set in the space thus provided, as shown in the accompanying illustration.

An Important Decision Sustaining the Tesla Patents.

On February 20 Judge Seaman, in the United States Circuit Court for the Eastern District of Wisconsin, handed down a decision sustaining the Tesla patents owned by the Westinghouse Electric and Manufacturing Company. The defendant was the National Electric Company, and infringement was claimed of the broad rights covered in Tesla patents Nos. 381,968, 381,969, 382,280 and 382,281. Judge Seaman, in Milwaukee, on February 24 enjoined the defendant company from the further sale of synchronous motors. The decision in the suit is the first that has been obtained in the litigation begun some time ago by the Westinghouse company to prevent the sale of synchronous motors and rotary converters by American manufacturers not enjoying a license under the Tesla polyphase motor patents. A decision is pending in the United States Circuit Court for the Southern District of Ohio in the suit brought by the Westinghouse company against the Bullock Electric Manufacturing Company, alleging infringement of the same patent rights. The final hearing in the latter suit was conducted before Judge Thompson, in Cincinnati, on February 7 and 8.

The Tesla patents involved in these suits have been the subject of considerable litigation in the past few years. The action instituted by the Westinghouse company a number of years ago against the Thomson-Houston Company, for alleged infringement of the Tesla patents, was discontinued upon the execution of a patent agreement under which the General Electric Company has for several years manufactured and sold induction and synchronous motors and rotary converters. A number of manufacturers have been enjoined from manufacturing induction motors, but the decision by the Wisconsin court is the first court ruling that the synchronous motor is within the generic Tesla invention. Judge Seaman's decision, covering the main points, is as follows:

"With the excellent and thorough review of the earlier patents and prior art, and the well considered concurrent view of the novelty and scope of the Tesla invention covered by the patents (thus appearing in several of these opinions) I am relieved of any need to attempt an analysis of the general showing in the present case, which departs from the prior cases only in respect of the application of the invention of the synchronous-motor type. Although the enquiry thus presented is not free from difficulty—involving abstruse discussion and distinctions in the electrical art which are perplexing to the non-expert understanding, and are not clarified by the many pages of conflicting expert testimony—the arguments at the bar were clear and well directed, and I am convinced that the issue as now presented is within narrow compass and governed by tests for its solution which are not complicated.

"The defendant's contentions are, in substance, that the Tesla invention, embodied in each of the patents, is the rotating field mode of operation, which is 'the production of the conjoint effect of out-of-phase currents of a progressive shifting by the polarity,' and thus 'identical in its effect with that of a rotating physical magnet;' that it is limited to a self-starting motor so operated and both by the terms of the patents and the state of the art, the defendant's synchronous motor with direct-current excitation is not within the invention; that the defendant's synchronous motor is simply a reversed 'two-phase alternating-current dynamo of the prior art used as a generator,' adapted to alternating use; and that the claims of patents 381,969 and 382,281, which bring in 'direct-current excitation producing synchronous operation,' must be limited to such use 'after the motor is started by the Tesla means and method and brought up to speed.' If the invention is so limited by the prior art it is plain that the defendant escapes infringement. On the other hand, if not so restricted, it is equally clear that the patents are broad enough to reach the defendant's means and methods of operation.

"The Tesla discovery for which these patents were granted revolutionized the art of electrical power transmission, as well demonstrated in the record from both judicial and scientific standpoints. Judge Townsend's definition in reference to the generic patents in the New England Granite case, repeatedly approved by other courts, is adopted for this consideration, namely, 'Tesla's invention, considered in its essence, was the production of a continuously rotating or whirling field of magnetic forces for power purposes by generating two or more displaced or different phases of the alternating current, transmitting such phases, with their independence preserved, to the motor, and utilizing the displaced phases as such in the motor.' So viewed the patent monopoly was rightly granted for its brief term to the use of the means and methods thus discovered. While it could not exclude the known uses of the prior art, it is surely entitled to be protected against like motor structure and mode of operation, not clearly disclosed in the prior art, and the patent claims to that end must be fairly construed in conformity with the rule applicable to such inventions. I am of the opinion, therefore, that the several contentions for the defendant are either without force or untenable for the following reasons:

"Whether the effect of the Tesla invention in its production of the 'whirling field of magnetic force' is identical with that of a rotating physical magnet, as argued by experts and counsel, does not impress me as material to this issue. Nor does it seem material that in the one form of motor 'the rotation is produced by the unaided effect of alternating out-of-phase currents,' as described by counsel, and that so applied a self-starting motor is obtained. The discovery was of means and method in the polyphase rotating field motor to produce the whirling field of force, and employment thereof was patentable with or without direct-current excitation of the armature or secondary element. So the fact that its use produced a self-starting motor without the aid of such excitation can not alone serve to limit the invention to that effect, and I find no such limitation in the terms of the patent. The quotations from the arguments of counsel and experts for the complainant in prior cases, urging the distinction of this self-starting effect in reference to the application of the generic patents to non-synchronous motors, are without force in the present controversy, and it is unnecessary to ascertain their consistency or inconsistency with the interpretation sought on this hearing. Unless limitation to self-starting motors arises out of the prior art none can be imposed upon the claims in suit.

"The further propositions urged by way of defence—aside from the defence founded upon prior inventions of the synchronous type to be considered—are these (1) that the synchronous motor of the defendant is the old generator of the art, simply reversed; and (2) that the Tesla invention is not present therein, because (as asserted) 'the prepondering magnetization of the' direct current displaced and obliterates the 'shifting alternating-current magnetization,' or Tesla 'whirling field of force.' However specious both propositions appear on their face and in the argument, neither of them impresses me as controlling.

"I believe that no proposition in the able and extended arguments on the part of the defence have been overlooked in my consideration of this case, although it has not seemed needful to discuss all of them for the purposes of this opinion. My conclusions are that the defendant's synchronous motor structure and operation are within the generic invention as patented, and expressly covered by the claims of Nos. 381,969 and 382,281; that the invention is utilized in the defendant's motor operation, notwithstanding the introduction of direct-current excitation to make it synchronous, in lieu of the full realization of the revolving field effect for self-starting; that such supplemental aid does not escape infringement, with or without advantage in such associations; and that, in any view the combination patents referred to are not limited to after-effect of the direct-current excitation, but apply to the defendant's combination. Decree will be entered accordingly as prayed in the bill.".

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

APPROPRIATION FOR CITY LIGHTING PLANT IN NEW YORK—The board of estimate of the city of New York, on Friday, February 24, appropriated $600,000 to buy a site and begin construction of a municipal electric lighting plant. Sites are recommended either on Blackwell's Island or on the bank of the East river, near the island.

BUFFALO TRACTION DEAL—Henry J. Pierce, of Buffalo, N. Y., and Nelson Robinson, a New York capitalist, and others have bought control of the International Traction Company, of Buffalo, N. Y., which is the holding company of the International Railway Company. The International Railway Company was organized February 20, 1902, when it took over the property of the old local company and also the Buffalo & Niagara Falls and other suburban lines. W. Caryl Ely, formerly of Niagara Falls, was elected president, and has continued in that office down to the present. Mr. Pierce is the president of the Chamber of Commerce of Buffalo.

STATION CHANGES IN THE INTERBOROUGH RAPID TRANSIT COMPANY'S SYSTEM—Because of the great pressure of traffic at the local subway stations between Brooklyn bridge and Ninety-sixth street and the limits of the combination express-local service the Interborough company, through August Belmont, its president, has requested the Rapid Transit Board to consider the lengthening of local platforms so as to permit the use of eight or ten-car trains, instead of the five or six-car trains that have been run thus far on the local tracks. It is expected that the board will take the matter up in the near future, so as to allow work to be begun as soon as the weather makes excavation practicable. It is expected that the work will involve the expenditure of about a million dollars.

TENNESSEE POWER PLANT—It has been announced that a lock and dam power plant, which will produce 30,000 horse-power, will be erected at a point in the Tennessee river, near Kelly's Ferry, Chattanooga, Tenn. For some time government dredging boats have been busily engaged in dredging the river at Kelly's Ferry to determine the kind of foundation which may be secured for the dam. It has been found that a stone foundation is located in the bottom of the river, near Kelly's Ferry, and there the lock and dam power plant is to be erected by C. E. James, of Chattanooga, and eastern capitalists. The Iona Cement Works, of Kansas, has purchased valuable lands near the site of the proposed lock and dam power plant, and a cement plant will be erected there with a capacity of 100 barrels per day, as soon as sufficient power can be secured to run the plant. It is given out that work will actually begin on the lock and dam power plant as soon as the spring freshets are over.

KANSAS CITY-ST. LOUIS TROLLEY—The construction of an electric railroad between St. Louis and Kansas City is promised in about two years. The Missouri Central Railroad Company, incorporated under the laws of Missouri two years ago, with a capital of $4,000,000, and which is to be shortly increased to $12,000,000, will operate this line. The Missouri Central Construction Company, incorporated under the laws of Delaware, with a capital of $1,000,000, will construct the line. Daniel F. Lewis, formerly connected with the Brooklyn Rapid Transit Company, is president of the latter company. The officers of the Missouri Central Railroad are: George B. Harrison, of Glasgow, Mo., president; Edwin W. Price, of Keytesville, vice-president; Howard Ellis, of New Florence, secretary, and Charles A. Lewis, of Kansas City, general counsel. The board of directors includes the officers named, with Daniel F. Lewis, of New York; Foster M. Voorhees, former governor of New Jersey; Edward Johnson, president of the People's Trust Company, Brooklyn; Walter Brownly, of Brooklyn; E. W. Grant, of Fulton, Mo.; the Rev. Dr. S. F. Taylor, of St. Louis, and Colonel W. H. Chase, of Toledo.

THE PLANS OF THE NEW YORK, WESTCHESTER & BOSTON RAILWAY COMPANY—Announcement has been made that the New York, Westchester & Boston Railway Company has reached an understanding with Mr. August Belmont, president of the Interborough Rapid Transit Company, whereby a terminal station for the interchange of traffic between the subway and the Westchester lines will be erected at some point between 149th and 170th streets. This arrangement will make the Westchester railroad practically an extension of the subway on the east side of the borough of the Bronx. The company is to furnish rapid transit to the upper section of New York city and Westchester County. The general supervision of the construction of the road will be under the direction of Mr. Samuel Hunt, vice-president of the company. The railroad will consist of four tracks on both the main line and branches, and will be built over right of way fenced in, and with no grade crossings on streets, highways, private roads or railroads. Ninety-pound rails will be used, laid upon tie-plates on oak ties, ballasted throughout with broken stone. The cars will be built of steel and fireproof material, vestibuled at each end. The full board of directors is as follows: William Lanman Bull, president; Samuel Hunt, vice-president; H. Carroll Winchester, secretary; Evans R. Dick, Charles E. Lewis, John B. Jackson, John R. McAllister, William Barclay Parsons, Robert C. Pruyn, Robert E. Robinson, Frederick E. Whitridge, Andrew Freedman and William H. Buckley.

SIMPLON TUNNEL PIERCED—The piercing of the Simplon tunnel through the Alps was completed at 7.20 o'clock on the morning of February 24. The work was commenced in 1898. The meeting of the two boring parties (Swiss and Italian) was signaled throughout Switzerland by the ringing of church bells and the salutes by cannon. President Ruchet sent congratulatory messages by telegraph to King Victor Emmanuel and Premier Giolitti, expressing the hope that the great work would further strengthen the friendship between Italy and Switzerland and add to their prosperity. The work of preparing the tunnel for a permanent way will be pushed as rapidly as possible, and it is hoped to inaugurate the tunnel about March 20. The length of the Simplon tunnel from Briga, in Switzerland, to Iselle, on the Italian side of the mountain, is about twelve miles. A very hard formation of rock was encountered at the outset on the Iselle side, which rendered necessary the construction of special machinery. After the boring had been pushed about two miles powerful cold springs were met, from which poured more than 500 gallons of water a minute, and for a time caused a suspension of all work on the Italian side. Hardly had this difficulty been overcome when about 200 feet further on a stratum of shifting material was encountered, and the further tunneling of about 150 feet required six months' time, and an expenditure of over $100,000. As the work proceeded it was found that the brickwork arch erected for the support of the finished portions of the tunnel was threatened with ruin, because of a slippery substance contained in the mountain's formation, and most of the work on the archway had to be gone over again. But the greatest difficulty encountered was last September, when hot water began to pour into the tunnel and caused a further suspension of work for several months, the temperature rising to 131 degrees Fahrenheit. On the Swiss or northern side there exists an accumulation of water which has been a constant menace to the workmen. Now that the borers have met this water can be drawn off. The Swiss and Italian governments jointly financed the tunnel undertaking, share and share alike, at the cost of $15,000,000.

TELEPHONE AND TELEGRAPH.

LYONS, N. Y.—The Wayne & Monroe Telephone Company is arranging to extend its lines further south.

FARGO, N. D.—The Tri-State Telephone Company's line between Grand Forks and Minneapolis is in operation.

GREENE, N. Y.—The Chenango Valley Telephone Company has completed a new line between Greene and Brisbin.

LONGMONT, COL.—The Colorado Telephone Company has completed a new toll line from Longmont direct to Platteville.

DAYKIN, NEB.—Money has been subscribed for the establishment of a telephone system, and work is to begin in the spring.

LISTOWEL, ONTARIO—The town council has decided to grant the Bell Telephone Company a five-year renewal of its exclusive franchise.

SHERBOURNE, N. Y.—The Sherbourne Telephone Company has extended its lines to Earlville, and will have an exchange at that place.

LEE, MASS.—Arrangements have been made to extend the farmers' telephone lines in East Lee, Tyrington, Otis, Becket and Washington.

OSWEGO, N. Y.—The Ontario Telephone Company will erect a large building in Oswego, and also purposes putting its wires underground.

LORAIN, OHIO—The Black River Telephone Company has authorized the expenditure of $15,000 for the improvement of its service in the vicinity of Lorain.

WILKESBARRE, PA.—The stockholders of the Consolidated Telephone Company have authorized a bond issue of $500,000, the intention being to use the money for improvements.

HUNTSVILLE, ALA.—A telephone exchange is being installed at Albertville, Marshall County, by the Southern Bell company. The town will be connected with Huntsville and Gadsden by long-distance telephone.

MOUNT MORRIS, N. Y.—The Mount Morris village board of trustees has granted a new franchise to the Inter-Ocean Telephone and Telegraph Company for the erection of a local telephone exchange in that town.

MANITOWOC, WIS.—The organization of a new independent telephone company has been effected. The line will traverse the Neshota road. The promoters are Charles Kiel, Henry Rohn, Fred Kiel and August Eberhardt, residents on the route.

CLINTON, N. Y.—The Independent Telephone Securities Company has purchased the plant and lines of the Clinton Telephone Company. The company operates exchanges in Clinton, Westmoreland, Paris Hill, Clark's Mills and adjacent villages.

PROVIDENCE, R. I.—The officers of the Providence Telephone Company have been reelected as follows: president, Dexter B. Potter; vice-president, Fenner H. Peckham; secretary and treasurer, Charles T. Howard; general manager, Joseph F. Beck.

DOYLESTOWN, PA.—The receivers of the Standard Telephone and Telegraph Company are having a new switchboard installed in the Yardley exchange. When this work is finished attention will be turned to the Langhorne exchange, which is also to be supplied with a new switchboard.

BOWLING GREEN, KY.—The stockholders of the Home Telephone Company elected the following officers at their annual meeting: I. F. Beard, of Huntington, Ind., president; E. B. Stout, first vice-president; W. B. Mayes, second vice-president; J. Whit Potter, treasurer; Hubert Myers, secretary; W. I. Allison, general manager.

SMITHVILLE, TEX.—At the annual meeting of the Smithville Independent Telephone Company the following directors were elected: H. C. Schumacher, J. W. Moore, W. D. Jones, Yerger Hill. The directors then elected the following officers: H. C. Schumacher, president; W. D. Jones, vice-president; J. W. Moore, secretary and treasurer; W. F. Lowen, manager.

KINGSTON, N. Y.—H. K. Rose, of South Kortright, who owns and operates nearly 500 miles of telephone lines in Delaware and Otsego counties, has bought a controlling interest in the Stamford village telephone exchange. New instruments will be installed, and it is also planned to build a supplementary circuit from Grand Gorge to Delhi, to be used principally for through business to New York, Kingston and Albany.

FINDLAY, OHIO—At the annual election of the Home Telephone Company the following officers were elected: president, E. C. Taylor, Findlay; vice-president, F. S. Dickson, Cleveland; treasurer, R. W. Judd, Cleveland; secretary and manager, George W. Vernor, Findlay; directors, E. C. Taylor, John C. Firmin and John D. Snyder, of Findlay, and J. B. Hoge, F. S. Dickson, W. T. Cary, Jr., and C. Y. McVey, all of Cleveland.

LIMA, OHIO—At the annual meeting of the Lima Telephone and Telegraph Company, D. J. Cable was reelected president and George L. Metheany secretary and treasurer. A detailed statement of the company's affairs shows over 400 new telephones placed. The directors voted to issue $10,000 additional preferred stock to bear five per cent interest, which will be placed on the market at once.

MISSOURI VALLEY, IOWA—At the annual meeting of the Interstate Telephone Company, of Harrison County, the following officers were elected for the ensuing year: W. A. Smith, president; A. Spooner, vice-president; C. J. Cutler, secretary; John Young, manager; H. M. Silsby, treasurer; W. J. Burke, of Missouri Valley; John Young and C. J. Cutler, of Modale; A. Spooner, of Mondamin, and F. M. Terry, of Little Sioux, directors.

NASHVILLE, TENN.—The annual meeting of the stockholders of the Cumberland Telephone and Telegraph Company was held recently. The report showed that thirty new exchanges were equipped and opened during the year. The net gain in subscribers was 17,569, making the total at the close of business, December 31, 1904, 121,313 subscribers. On February 1 the company made an increase of fifteen per cent in its capital stock, the increase amounting to $1,754,300.

ALBANY, N. Y.—The Frankfort, East & West Schuyler Mutual Telephone Company has been incorporated with the secretary of state to build a line from the village of Frankfort to East and West Schuyler, then to Utica, where Bell telephone connections will be made. The capital is $1,000. Directors are: Aaron Eaton, E. J. Ladd, Walter Klock, H. Robinson, H. L. Burch, S. P. Johnson, R. H. Smith, H. S. Cristman, J. H. J. Watkins, H. L. Johnson, Newell Miller, C. M. Rose and W. M. Wilbur.

PITTSBURG, PA.—The Pittsburg & Allegheny Telephone Company has announced that the long-distance lines connecting Pittsburg with Northern Central and Western Pennsylvania, and also Ohio and West Virginia, which have been in process of construction, are now completed. Direct lines to Wheeling, W. Va., and to Butler have also been completed. Additional lines to Johnstown and Uniontown, Pa., connecting with lines to Baltimore and Philadelphia, are now in process of construction.

LEXINGTON, KY.—At the annual meeting of the Fayette Home Telephone Company the president made an itemized statement of the finances for each quarter, and also for the entire year ending December 31, 1904. These reports showed that the net income for last year was $59,599.73 as against $55,766.80 for the year preceding. The reports also showed that after charging off operating expenses and salaries there was a net earning for last year of $29,211.31, which sum was divided as follows: interest on bonds, $14,300; charged off for reconstruction and maintenance, $11,430.17, leaving a net surplus of $3,381.14. The following officers were elected for the ensuing year: George S. Shanklin, president; A. Smith Bowman, vice-president; Charles Kerr, secretary, and J. W. Stoll, treasurer.

WASHINGTON, D. C.—The report of the Chesapeake & Potomac Telephone Company shows that the receipts from telephone earnings in the calendar year 1904 were $604,193.66, and from real estate earnings $38,989.95, a total of $643,183.61. The expenditures were as follows: general administrative expenses and taxes, $89,328.30; traffic expenses, $177,864.36; maintenance, $204,309.43; rentals and sundries, $32,751.65; real estate expenses, $38,757.65; interest charges, $83,539.21; miscellaneous expenses, $59.21, a total of $626,806.30. The net earnings from all sources were $16,377.31. The report shows that the receipts and expenditures on account of property in the District of Columbia were as follows: proceeds of company's notes, $453,600.86; construction of conduits and cables, $137,671.86; construction of poles, etc., $42,113.80; central office equipment, $273,815.20; total expenses, $453,600.86.

The value of the company's property, not including real estate, is given as $2,439,745.61.

CHARLTON, N. Y.—The Galway Telephone Company will extend its line from West Charleton to Birchton.

ELM GROVE, W. VA.—Poles have been set for a new telephone line to Fulmers, about four miles up Wheeling creek.

LYONS, N. Y.—The Wayne & Monroe Telephone Company is preparing to extend its lines through to Wolcott, to connect with the independent exchanges at that place.

CAPE MAY, N. J.—The Citizens' Local Telephone Company has been organized at Cold Spring, to connect that town and adjoining villages with the lines of the South Jersey Telephone Company at Cape May.

SALEM, ILL.—The Seven-Mile Prairie Telephone Company has been organized, with Charles Gehrig as president; Charles McDonald, vice-president; William Parkerson, secretary; Charles Davis, treasurer, and Charles Sanders, John Gregg and Boyd Henry, directors.

GADSDEN, ALA.—A telephone line is to be constructed between Ohatchie, on the Seaboard Air Line, and Ingram Wells, the Calhoun County summer resort. Work is to be commenced on the line as soon as the weather will permit, in order that the line may be ready by early spring.

BENZONIA, MICH.—At the annual meeting of the Benzie County Telephone Company it was shown that the company was in a prosperous condition. The capital will be increased to $100,000. W. A. Young was chosen president for the ensuing year, and H. B. Woodward, secretary and treasurer.

LIVINGSTON, TEX.—At a meeting of stockholders of the Livingston Telephone exchange the secretary's report showed that the receipts paid all expenses, with a small margin of profit. S. H. Smith, J. E. Hill, Jr., L. F. Gerloch, G. F. Sawyer and B. C. Marsh were elected directors for the ensuing year, with the first two as president and secretary, respectively.

JEFFERSON CITY, TENN.—An independent telephone company has been organized, with headquarters at Piedmont, known as the Piedmont Telephone Company. The following are the officers: William R. West, general manager; W. M. Brooks, secretary; J. Randle French, Thomas Hudson, John Milligan, Alfred Caldwell, J. Underwood, directors. This line will run from Piedmont to Knoxville, Kodak, Strawberry Plains, New Market, Jefferson City and Dandridge.

GAINESVILLE, FLA.—The East Florida Telephone Company, a line owned and operated by Gainesville parties, will be extended to Ocala. The system connects Gainesville with Archer, Micanopy, Evinston, McIntosh, Rocky Point, Tacoma, Palmer, Arredondo, Kanapaha, Rochelle, Windsor, Fairbanks and intermediate points. It is proposed to begin the extension to Ocala from McIntosh as soon as arrangements can be made, after which the line will be extended to Waldo, Melrose and other points.

WHITEHOUSE, N. J.—The annual meeting of the Lebanon Telephone Company was held recently at the offices of the organization at Lebanon. The following officers were chosen: president, S. J. Shurts; vice-president, George Clark; secretary, G. W. B. Tiffany; treasurer and general manager, E. W. Sutton; board of directors, the foregoing and O. A. Farley, J. C. Farley and Dr. H. H. Miller. At a meeting of the stockholders of the company it was voted to increase the capital from $5,000 to $25,000, and to have the state charter of the concern amended so that the company can build its lines anywhere in New Jersey. At present the Lebanon line is operating only in Hunterdon, Somerset, Warren and Morris counties. It was also decided to extend the service to several new points as soon as the weather will permit.

ELECTRICAL SECURITIES.

Last week recorded a further advance in the general average of security values. On the last day of the week a new high record of transactions was made, with sales of 1,309,300 shares. This compares with the previous record for a Saturday, of April 20, 1901, with 1,113,900 shares. As an evidence that considerable interest is being manifested by the buying public there has been a decided increase in commission business. It is now certain that no legislation will be enacted at this session of Congress, looking to any radical interstate rate regulation. This removes an uncertain factor, and gives an added impetus to speculation in many lines. The leading part now being taken by electric railroad securities, and the splendid showing that the Interborough Rapid Transit Company, in New York city, is making in the way of a dividend-earning proposition, will exert a powerful influence in the direction of hastening the electrification of present steam roads, and the construction of new electrical lines, both for passenger and freight service. This will mean greatly increased manufacturing, and will, of course, divert considerable money into purely electrical channels. The strong financial support which is being accorded to almost every security offering of value indicates that there will be no lack of money to finance new construction when plans are consummated for the inauguration of the work.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 25.

New York:	*Closing.*
Brooklyn Rapid Transit	63⅜
Consolidated Gas	204
General Electric	187
Interborough Rapid Transit	205
Kings County Electric	200
Manhattan Elevated	172¼
Metropolitan Street Railway	120½
New York & New Jersey Telephone	171
Westinghouse Manufacturing Company	190

At the annual stockholders' meeting of the New York & New Jersey Telephone Company the old board of directors was reelected. Other business was routine.

Boston:	*Closing.*
American Telephone and Telegraph	146
Edison Electric Illuminating	252
Massachusetts Electric	58
New England Telephone	136
Western Telephone and Telegraph preferred	103

It has been decided to finance the requirements of the American Telephone and Telegraph Company for 1905 by an issue of $25,000,000 bonds. The bonds will carry 4 per cent interest. Bids were scheduled to be received March 1, and payments to the American company will be at the rate of $2,000,000 a month.

Philadelphia:	*Closing.*
Electrical Company of America	12⅛
Electric Storage Battery common	89¼
Electric Storage Battery preferred	89¼
Philadelphia Electric	11¼
Philadelphia Rapid Transit	31¼
United Gas Improvement	115⅞

A special meeting of the Philadelphia Rapid Transit stockholders will be held April 25 to authorize the company to join as guarantor to the $10,000,000 bonds of the Market street elevated passenger railway. The balance sheet of the company as of June 30, 1904, shows assets of $12,002,543, and liabilities of $11,379,869, leaving a surplus of $622,674.

Chicago:	*Closing.*
Chicago Telephone	142
Chicago Edison Light	170
Metropolitan Elevated preferred	62
National Carbon common	42
National Carbon preferred	114¼
Union Traction common	11
Union Traction preferred	48

South Side Elevated directors have declared the regular 1 per cent quarterly dividend, payable March 31. Books close March 21, and reopen April 1.

The Illinois Supreme Court has affirmed the ruling of the Appellate Court, that the Chicago Union Traction Company must lower the Van Buren street tunnel under the Chicago river at its own expense.

NEW INCORPORATIONS.

YOE, PA.—Yoe Electric Light Company. $5,000.

MONROE, MICH.—Stoddard-Osgood Telephone Company. $10,000.

CHANDLER, OKLA.—Stroud Light and Power Company. $15,000.

TORONTO, ONTARIO—Markham & Pickering Telephone Company. $40,000.

WASHINGTON, PA.—West End Electric Light, Heat and Power Company. $25,000.

DAYTON, OHIO—Richwood Telephone Company. Increased from $20,000 to $50,000.

MARIETTA, OHIO—Marietta Telephone Company. Increased from $50,000 to $100,000.

STONY POINT, IND.—Home Mutual Telephone Company. Increased from $10,000 to $30,000.

COLUMBUS, OHIO—Barlow & Watertown Telephone Company. Increased from $10,000 to $16,000.

NEWARK, N. J.—Butte Electric and Power Company. Increased from $2,500,000 to $3,000,000.

AURORA, ILL.—Hayes Electric Company. $3,000. Incorporators: T. J. Hayes, E. R. Price and Frank La Sauer.

BETHEL, ME.—Middle Intervale Telephone Company. $1,000. President, O. A. Buck; treasurer, C. C. Bryant, both of Bethel.

ALBION, ILL.—Edwards County Mutual Telephone Company. $4,048. Incorporators: Philip King, William H. Reid, T. B. Mitchell.

LAFAYETTE, WIS.—Wilcox Valley Telephone Company. $2,500. Incorporators: Albert E. Harris, Charles J. Fox and Thomas Grady.

TIPTON, IND.—Fairview Cooperative Telephone Company. $1,025. Incorporators: W. H. Achenbach, L. J. Boull, John McCrory.

DOWNSVILLE, WIS.—Downsville Telephone Company. $3,500. Incorporators: J. F. Dennhan, George McCarty, Uriah Anderson and others.

FIELDON, ILL.—Western Telephone Company. $960. Incorporators: Frank F. Loelike, Francis A. Marks, and A. W. Pinkelmann.

TURTLE CREEK, PA.—The Rose Electric Light and Power Company. $20,000. President, William L. Ledger; secretary, C. R. Trevaskis.

CLEVELAND, OHIO—Gillen Electric Company. $10,000. Incorporators: S. H. Gillen, E. J. Gillen, D. F. Streb, W. S. Rowell, A. L. Vermilye.

AMHERST, ME.—Union River Telephone Company. $8,000. Incorporators: A. E. Mace, H. T. Silsby, both of Aurora; J. H. Patten, of Amherst.

RETREAT, WIS.—Vernon County Telephone Company. $5,000. Incorporators: A. J. Broadhead, J. L. Davis, F. P. Bean, W. P. Morand, Anna Esch.

BATTLE GROUND, IND.—Battle Ground Telephone Company. $1,500. Incorporators: Edward Towers, William J. Walters and Thomas D. Chenoweth.

MAPLEHURST, WIS.—Withee & Maplehurst Telephone Company. $1,000. Incorporators: Wallace D. Clemons, John Christensen and John Laneville.

YELLVILLE, ARK.—Yellville Telephone Company. $150,000. Incorporators: V. H. Weart, L. M. Weart, S. L. Brooksher, R. R. Brooksher and G. A. Ward.

RICHMOND, VA.—Southern Bell Telephone and Telegraph Company of Virginia. $200,000. Incorporators: W. T. Gentry, F. E. Montague, William H. Sands.

PORTERSVILLE, OHIO—Triadelphia-Sayre Telephone Company. $5,000. Incorporators: B. H. Petit, M. R. Hearing, H. C. Hearing, M. C. Smith and J. C. Masterton.

COSHOCTON, OHIO—Coshocton County Telephone Company. $30,000. Incorporators: Joseph A. Finlay, James L. Beck, J. H. Elder, W. D. Kissner and S. C. Kissner.

PEKIN, ILL.—Petersburg Telephone Company. $20,000. President, George H. Glass, Pekin; secretary, George N. Kelly, Petersburg; treasurer, B. G. Henion, Petersburg.

NORTH ADAMS, MASS.—Bennington & North Adams Street Railway Company. $150,000. President, A. H. Rice, of Pittsfield; O. M. Barber, of Bennington, Vt., treasurer.

ELLSWORTH, IND.—Otter Creek Telephone Company. $1,200. Incorporators: George L. Stevenson, William F. Carty, S. D. Humphrey, all of Edwards P. O., Vigo County, Ind.

ROCHESTER, N. Y.—Eastern Monroe Electric Light and Gas Company. $250,000. Directors, Henry C. Brewster, Rochester; Andrew H. Brown, Penfield, and Walter A. Parce, Fairport.

LEBANON, OHIO—The Miami Transit, Light and Power Company. $600,000. Incorporators: F. O. Richards, M. D. Burke, Joseph S. Storr, C. A. Culbertson and Charles A. Hough.

COLUMBUS, OHIO—Dillonvale Heat, Light and Water Company. $50,000. Incorporators: William M. Dages, Frank Alexander, David I. Sennecker, W. L. Cole and Ralph E. Bartlett.

NORRISTOWN, PA.—Linfield Electric Light Company. $5,000. Incorporators: Horace Ashenfelter, Royersford; William S. Emlig, Philadelphia; G. E. Brownback, Linfield; A. H. Fry, Jr., Philadelphia.

HOULTON, ME.—Houlton Electric Light and Power Company. $10,000. President, H. T. Frisbee, Houlton; W. P. Manser, Houlton; directors, as above named and C. H. Pierce and J. A. Tenney, Houlton.

MOUNT HOLLY, N. J.—Lumberton Light, Water and Sewage Company. $50,000. Incorporators: George F. Ried, J. M. Harrison, Walter M. Voorhees, Henry Conrow and Moses S. Watson, of Lumberton.

TORONTO, ONTARIO—Scarboro Telephone Company, Limited. $40,000. Directors: Alexander Neilson and John Neilson, of Scarboro; Thomas Albert Young, of Markham, and William Mulock, Jr., of Toronto.

COLUMBUS, OHIO—Bucyrus Springs & New Washington Traction Company, of Bucyrus. $10,000. Incorporators: Ellis Bartholomew, William E. Moser, Samuel S. Thorn, Fred W. Armbruster and Elmer Luke.

PATERSON, N. J.—Beaver Lake Company; to supply electrical power, build and operate waterworks, etc. $50,000. Incorporators: Wayne Dumont, John A. Kane, Frank Wilson, of Paterson, and Denton W. Clark, of Green Pond.

ZANESVILLE, OHIO—Zanesville, Coshocton & New Philadelphia Traction Company. $10,000. Incorporators: John W. Cassingham, Arthur F. Stanley, G. A. Hay, H. C. Ferguson, J. L. Barnett, John U. Kissner and John A. Hanlon.

BERKELEY SPRINGS, W. VA.—Berkeley Springs Light and Water Company. $25,000. Incorporators: Henry N. Hanna, Eugene L. Morton, of Baltimore, Md.; J. Frank Fields, of Hancock, Md.; T. H. B. Dawson, Silas J. Honermall and Rumanus Hunter, of Berkeley Springs, W. Va.

HARRISBURG, PA.—Harmony Light and Power Company, of Harmony, $5,000; Jackson Light and Power Company, of Jackson Township, $5,000; Zelienople Light and Power Company, of Zelienople, $5,000. Incorporators: J. A. Frauenlein, W. H. Lose, Edwin Meeder, all of Zelienople.

SWEETWATER, ILL.—Springfield, Sweetwater & Peoria Electric Railway Company; to be constructed from Springfield, Ill., to Peoria, *via* Sweetwater. $2,500. Incorporators and first board of directors: George H. Hatch, Greenview, Ill.; Thomas H. Alkire, John W. Terhune, James E. Culver and Augustus K. Jones, of Sweetwater, Ill.

SAVANNAH, GA.—Savannah Lighting Company. $50,000, with the privilege of increasing to $500,000. Incorporators: John J. Cummings, Lawrence McNeil, J. H. Estill, Joseph D. Weed, Henry Blun, Samuel Meinhard, Willis A. Burney, Jr., John Flannery, Samuel B. Adams, Pleasant A. Stovall, J. H. H. Entelman, B. H. Levy, George W. Tiedeman and Leopold Adler.

AUTOMOBILE NOTES.

CLUB-HOUSE AND GARAGE FOR AUTOMOBILE CLUB OF AMERICA—The building committee of the Automobile Club of America, composed of Albert R. Shattuck, Colgate Hoyt and Dr. Schuyler Skaats Wheeler, announces the purchase of a plot of land in New York city, on the northerly side of Fifty-fourth street, about two hundred and fifty feet west of Broadway, having a frontage of one hundred and thirty-one feet, and a depth of one hundred feet and five inches. The property is at present covered by private dwellings. On this site the club will at once erect its new club-house and garage. The land and building will cost something over half a million of dollars. The building will be of the most modern fireproof construction, and it is designed to be a model structure of the kind both from the standpoint of architecture and utility. The location is accessible, and in a part of the city where the automobile interests are rapidly concentrating. The architect is Ernest Flagg.

RELIEF FROM FERRY RESTRICTIONS—The Automobile Club of America announces that the Platt-Gouden bill was signed by President Roosevelt on February 20, amending section 4472 of the revised statutes, so as to remove certain restrictions upon the transportation by steam vessels of gasoline and other products of petroleum when carried by automobiles using them as a source of power. The amended section reads as follows: "Nothing in the foregoing or following sections of this act shall prohibit the transportation by steam vessels of gasoline or any of the products of petroleum when carried by motor vehicles (commonly known as automobiles) using the same as a source of motive power. Provided, however, that all fire, if any, in such vehicles or automobiles be extinguished immediately after entering the said vessel, and that the same be not relighted until immediately before such vehicle shall leave the vessel. Provided, further, that any owner, master, agent or other person having charge of passenger steam vessels shall have the right to refuse to transport automobile vehicles the tanks of which contain gasoline, naphtha or other dangerous burning fluids."

OBITUARY NOTICES.

MR. CALVIN DETRICK, an early promoter of electrical enterprises, died on Saturday, February 18. He was president of the Staten Island, N. Y., Light, Heat and Power Company, and erected the first electric lighting plant in the borough of Richmond. He also constructed the system of water supply for the borough of Richmond, and was the builder of the first underground electric light supply system in Philadelphia, Pa. He was born in Monroe County, Pa., May 4, 1838, and although his office was in Stapleton, S. I., his home was in Brooklyn, N. Y.

MR. A. P. GODDARD, president of the Freeport Railway, Light and Power Company, a member of the National Electric Light Association, died at his home in Freeport, Ill., on Tuesday, February 12, at the age of seventy-two. He was born in Franklin County, N. Y., but his family removed to Freeport when he was two years old. Mr. Goddard was prominently identified with the development of Freeport, having served as alderman, mayor and member of the board of supervisors. He also served in the Civil War as first lieutenant in the Illinois Volunteer Infantry, and was brevetted a captain for honorable service. Mr. Goddard was a prominent freemason.

MR. EDWARD COOPER, ex-mayor of the city of New York, and the only son of Peter Cooper who lived to manhood, died on Saturday afternoon, February 25, at his home, 12 Washington square, New York city, of apoplexy. Mr. Cooper was in his eighty-first year. For the last few years he had not been active in business, though he was still a member of the firm of Cooper Hewitt & Company. He was born in New York city on October 26, 1824. He went to the public schools, and was in Columbia University in the class of 1845. He was in delicate health, and did not graduate, and in 1842 his father engaged Mr. Abram Hewitt to take him abroad as tutor. Mr. Cooper was a strong Democrat, and had been in public life from 1857 until 1896. In 1857 he was made street cleaning commissioner, and in 1878 was elected mayor of the city of New York. In the meantime he had served as delegate to the Charleston convention of 1860. He was president of Cooper Union for the Advancement of Science and Art, his father's gifts to which he very much increased. He was president of the Trenton Iron Company, and a member of the Union Club, Metropolitan, University and Knickerbocker clubs, and of the Century Association. The funeral was held at Grace Church, New York city, at ten o'clock Tuesday morning, February 28.

PERSONAL MENTION.

MR. H. M. HOBART has been appointed lecturer in electrical engineering design at the Northampton Institute, London. He succeeds Mr. E. K. Scott.

DR. WILLIAM R. HARPER, president of the University of Chicago, is suffering from an acute cancerous affliction. It has been decided to make a very complete test of the efficacy of the X-ray treatment as a cure for cancer and the destruction of cancerous growth in the tissues.

MR. F. D. PHILLIPS has been appointed general manager of the American Electrical Supply Company, 83-87 Fifth avenue, Chicago, Ill. Mr. Phillips's five years' experience with the Electric Appliance Company, and later as treasurer and sales manager of the Crescent Company, eminently fit him for the duties of his new position.

MR. CHARLES W. CROSS, M. E., E. E., formerly of the Roberts & Abbott Company, consulting engineers, of Cleveland, Ohio, and later electrical engineer for the Eastern Ohio Traction Company, has entered the employ of the Crocker-Wheeler Company, of Ampere, N. J., and is attached to the Cleveland office of the company at 816 New England Building.

MR. J. D. HOUSEMAN has resigned as general manager of the Suburban Telephone Company, St. Louis, Mo. He will engage in electric railway work. Mr. Houseman promoted the first street car line in St. Louis County, the branch of the Suburban system from Forrest Park to Kirkwood, and later completed an electric line to St. Charles.

MR. HENRY L. MANNING announces his retirement from the firm of Manning, Maxwell & Moore, he having sold his entire interest to his partner, Mr. Charles A. Moore. Mr. Manning requests that the many friends will continue their pleasant relations with the firm. The business will be conducted under the firm name of Manning, Maxwell & Moore, at 85-89 Liberty street, New York city.

MR. ARTHUR B. LISLE, assistant manager of the Narragansett Electric Lighting Company, Providence, R. I., has resigned to engage in a brokerage business. Mr. Lisle has been with Mr. Marsden J. Perry, president of the company, as confidential clerk, for about six years. He was also treasurer of the East Providence Water Company, and is interested in the Putnam, Ct., Water and Lighting Company.

MR. CHARLES R. UNDERHILL, formerly chief electrical engineer of the Varley Duplex Magnet Company, has engaged in consulting engineering, with headquarters at 55 Liberty street, New York city. He will make a specialty of the design of electromagnets and solenoids in general, but particularly for heavy power work. He will also take contracts for the complete construction of magnets and solenoids to perform a given duty. Mr. Underhill is the author of a book entitled "The Electromagnet," which treats the subject from the standpoint of design.

MR. B. T. BURT, one of the pioneers in electrical work, is the efficient general manager of the Chattanooga Electric Company, Chattanooga, Tenn. This plant was described in last week's issue of the ELECTRICAL REVIEW. Under Mr. Burt's management the plant of the company has been greatly enlarged, and, in addition to supplying light and power for the city of Chattanooga, Tenn., the company has taken over the entire load of the street railway company. Mr. Burt was an early associate of Thomas A. Edison, in much of the great electrician's early work, in New York city.

ELECTRIC RAILWAYS.

INDIANAPOLIS, IND.—The Winona Interurban Railroad Company will erect a $600,000 power plant at Warsaw.

DENVER, COL.—The Denver & Intermountain railway is to be extended to Idaho Springs, a distance of between twenty and thirty miles.

BIG STONE GAP, VA.—It is announced that an electric line will be built from Big Stone Gap, *via* Stone, Apalachia and Norton, to Wise, a distance of thirty miles. This will open up valuable mining property.

MOBILE, ALA.—It is stated on good authority that a syndicate of Indianapolis capitalists is planning an electric road between Mobile and New Orleans. The work of surveying the route will begin at an early date.

CLEVELAND, OHIO—The Northern Ohio Traction and Light Company has decided to spend $100,000 in improvements on its lines during the present year, and the engineering department is now at work on the plans.

ARDMORE, I. T.—A franchise has been granted by the Ardmore city council for the construction of an electric line. Right of way was given through the principal streets, and work is to be commenced by September 1.

OTTAWA, OHIO—The Cincinnati Northern Traction Company, which has recently been chartered to operate electric lines, with Cincinnati and Toledo as the termini, will pass through the western part of Putnam County.

WASHINGTON, PA.—Representatives of a Philadelphia company are taking up rights of way for a trolley line from a point near Bridgeville in Allegheny County up Miller's Run in the central section of Washington County.

NORTH ROSE, N. Y.—Steps have been taken to build an electric railway from Clyde to Sodus bay, with the probable terminal at the north end of Resort, which is at the head of Sodus bay. The railway will be called the Clyde & Sodus Bay Railway.

PITTSBURG, PA.—The Shenango Traction Company, which will build a line from Meadville to New Castle at a cost of $1,500,000, has been granted a franchise by the council of West Middlesex borough. Wheatland, Clarksburg and Greenville have also granted franchises.

LOUISVILLE, KY.—The fiscal court has passed a resolution granting the Kentucky Traction Company an extension of time in which to complete the electric line on the Eighteenth street road. The company is allowed two years more for the completion of the line to Valley Station, and four years for the building of the line to Riverview.

ST. PAUL, MINN.—The city council of Excelsior has granted E. J. Phelps and F. A. Kenaston a franchise for an electric railway between Hopkins and Excelsior, with permission to establish branch lines around lake Minnetonka. The applicants agreed to execute a bond in the sum of $5,000 that the line would be in operation within two years.

GREENSBURG, PA.—A company of coke region capitalists, headed by O. W. Kennedy, of Uniontown, has secured the right of way for a trolley line from Mt. Pleasant to Latrobe. The line will run through an undeveloped region of the coke country, the following towns being touched: Trauger, Calumet, Mammoth, Hecla and Baggaley. At the latter town the line will connect with the Latrobe Railway Company. Construction will begin in the spring.

ST. JOSEPH, MO.—The county court has granted a franchise to the Maryville & St. Joseph Electric Railway Company to cross with its line of railway all public highways between the city of St. Joseph and the north line of Buchanan County. It is specified in the order granting the franchise that if the road is not completed within two years of the date on which the franchise is granted the company must then put up a $5,000 bond to ensure its completion in a time specified by the court.

SPOKANE, WASH.—A corporation has been formed at Everett, Wash., with a capital stock of $2,000,000, to build an electric railway from Everett to Bellingham. The incorporators are Charles W. Taylor and R. W. Jacobus, eastern capitalists, and J. E. Stauffer and William M. Ross, of Everett. The company proposes to purchase the right of way the entire distance, and to build an independent line. It is claimed the funds for the construction of the road have all been provided for. The articles of incorporation have been filed in Snohomish, Skagit and Whatcom counties.

MARION, IND.—The commissioners of Grant County have granted a franchise to the Geneva Traction Company, which proposes to build an electric road east from Marion to Celina, Ohio, passing through Montpelier, Dundee and other Indiana cities. The road will connect the oil regions of Ohio and Indiana. The company has obtained a franchise in each county and city through which it will pass, and has bought a private right of way almost the entire distance between Marion and Celina. The company will begin construction as soon as the weather will permit.

NEW PUBLICATIONS.

DIE ABSTIMMUNG FUNKENTELEGRAPHISCHER SENDER—Dr. A. Slaby has issued, in pamphlet form, his recent series of articles in the *Elektrotechnischer Zeitschrift*, which treats of the classification of wireless telegraph systems.

ANNUAL REPORT OF THE UNITED STATES LIGHTHOUSE BOARD—The annual report of the United States Lighthouse Board for the year ending June 30, 1904, has been issued by the department of commerce and labor, Washington, D. C.

THE SOUTHWESTERN ELECTRICIAN—The first issue of the *Southwestern Electrician* has been distributed. This journal is published by the Southwest Publishing Company, Southwest Building, 910 Texas avenue, Houston, Tex. Mr. Charles A. Newning is manager.

REVIEW OF NAVAL PUBLICATIONS—The United States Navy Department has printed a report prepared by Commander L. A. Lan, of the Argentine navy, on the submarine boats of the Lake and Holland types. This report has been translated by Mr. M. E. Beall, of the United States War Department.

THE INDIAN TEXTILE JOURNAL DIARY AND REFERENCE BOOK—The *Indian Textile Journal*, Bombay, India, has issued its diary and reference book for 1905. This contains a great deal of information valuable to the textile engineer or manager, lists of Indian and British patents of interest to textile operators, and rules relating to certificates and examinations for mechanical engineers in India. There are also very complete lists of cotton mills in India, Japan and China, and a diary.

THE AMERICAN UNDERWRITER—The tenth anniversary special vellum number of the *American Underwriter* is indeed a handsome publication. Inclusive of advertising, the work represents forty-four pages of carefully selected material, fine typography and good presswork. The supplement to this tenth anniversary number is a photogravure of John A. McCall, president of the New York Life Insurance Company. The work has been compiled by, and is issued with the compliments of, Edward Bunnell Phelps, editor of the *American Underwriter*.

INDUSTRIAL EDUCATION AND INDUSTRIAL CONDITIONS IN GERMANY—The Department of Commerce and Labor, Washington, D. C., has compiled the consular reports on industrial conditions and industrial education in Germany, and has issued these in pamphlet form. The report is fairly complete, discussing the German system of education and the evolution of the German industrial schools, the engineering schools and schools of technology. Industrial and commercial schools are described, and the methods of administration explained. The reports upon the industrial conditions in Germany cover practically all districts. An appendix contains reports of technical schools at Roubaix and Lisle, France; commercial schools in Japan, and technical education in London. Illustrations of a number of well-known technical schools in Germany are given.

ELECTRIC LIGHTING.

HOPE, IND.—George S. Cook has secured a franchise to establish an electric light plant at Hope.

INDIANAPOLIS, IND.—The Brazil Electric Company has secured a site upon which to build a power plant in the spring.

LUTHERVILLE, MD.—Lutherville is now lighted by electricity furnished by the Mount Washington Electric Light and Power Company.

COOKVILLE, TENN.—The contract for the electric light plant has been awarded to McDonald, McCoy & Company, of Chicago, their bid being $25,159.

FAYETTEVILLE, ARK.—New machinery has been added to the electric light plant at Fayetteville, which gives the plant a capacity of 5,500 incandescent lights.

ANADARKO, OKLA.—The city council has let a contract for the construction of an electric lighting plant to the Union Light and Power Company, of El Reno, Okla. The cost will be $10,455.

LEAD, S. D.—The Homestake Mining Company has purchased the Spearfish Electric Light and Power Company's property, which furnishes light and power for Spearfish, the consideration being $18,000.

SEMINARY, MISS.—The Mason Lumber Company, whose plant is located at Pratt station, will put in a large electric lighting plant at an early date. The company will also furnish lights for Seminary.

SAN FRANCISCO, CAL.—The Bay Counties' Power Company will transfer its power line from the north to the south side of the Yuba river. A new electric railroad connecting Marysville and Yuba City will be constructed, following the river west from a point four miles below Marysville.

MILLIS, MASS.—The new electric lighting system installed by the Medfield Electric Light and Power Company has been completed. Over 125 incandescent lights of twenty-five candle-power have been placed in position. The selectmen have entered into a three years' contract with the company.

ROCHESTER, N. Y.—At a meeting of the directors of the Eastern Monroe Electric Light and Gas Company the following officers were elected: president, Andrew H. Bown, Penfield; vice-president, Walter A. Parce, Fairport; treasurer, Henry C. Brewster, Rochester; secretary, Clarence E. Shuster, Penfield.

LITTLE FALLS, N. Y.—T. N. Lovenheim, owner of the Consumers' Electric Light Company, has sold a half interest in his company to William LaDue. Mr. Lovenheim announces that the capacity of the plant will be doubled, a new dynamo having been ordered, which will increase the service by 1,500 lamps. The company is also rebuilding the structure which was recently burned.

PHILADELPHIA, PA.—At the annual meeting of the United Power and Transportation Company held in Camden the old board of directors was reelected. The annual report of the company for the fiscal year ended December 31 compares as follows: income from securities and loans, $708,512; expenses, taxes, fixed charges, etc., $364,056; balance for dividends, $344,456; dividends, $343,562; surplus, $894; total surplus, $267,078.

SHREVEPORT, LA.—H. N. Morris, president of the Shreveport Gas, Electric Light and Power Company, has closed a deal whereby the Dawes syndicate, owning the Shreveport gas and light plants, acquires the plants at that place, the transaction involving in the neighborhood of $200,000. It is the intention of the purchaser to spend considerable money in the improvement of the property. The officers of the new Texarkana company will be: president, H. N. Morris, Shreveport; vice-president, R. C. Dawes; secretary, J. B. Sherman.

MARTINSBURG, W. VA.—Capitalists of Washington and Baltimore are organizing a stock company for the purpose of purchasing the old pulp mills and water power at Harper's Ferry, where it is intended to erect a large electric light plant. It is said that $150,000 has been subscribed, and that the venture is already assured. It is expected to make this plant a central point for supplying electric light to several cities and towns in the valley, and negotiations are under way with Winchester, Brunswick, Harper's Ferry, Charlestown, Hagerstown, Williamsport and other places.

NOBLESVILLE, IND.—At a special meeting of the Noblesville city council a ten-year contract for lighting the city was awarded to George W. Heinzmann & Company. The company is required to furnish eighty arc lights at $70 a light per year, and ten cents a thousand watts will be charged for incandescent lights. The old electric light company, which now has the contract, and the Noblesville Hydraulic Company are consolidated with the new company. The large dam across White river, north of Noblesville, which the Hydraulic Company began two years ago, but which was not completed on account of an injunction, will be finished. The old company's present steam plant will be remodeled and held in reserve in the event of the dam power not being available at all times. The two plants, when in operation, will represent an investment of $150,000.

ENGINEERING SOCIETIES.

ENGINEERS' CLUB OF ST. LOUIS—The regular meeting of the Engineers' Club of St. Louis was held at the club rooms, 3817 Olive street, St. Louis, Mo., Wednesday evening, March 1. Mr. Carl Gayler presented a paper entitled "Our Grade-Crossing Problems."

TORONTO BRANCH, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The sixteenth regular meeting of the Toronto branch of the American Institute of Electrical Engineers was held at the School of Practical Science, February 24. Mr. B. G. Lamme's Institute paper, entitled "Synchronous Motors for Regulation of Power-Factor and Line Pressure," was read and discussed.

LEGAL NOTE.

ELECTRIC FUSE LITIGATION—Concerning a note appearing recently in this department, the following has been received: "I notice under the head of 'Legal Notes' in your issue of February 18, 1905, on page 311, the following: 'Electric Fuse Litigation—In the suit of the American Electric Fuse Company against the Rolfe Electric Company and Charles A. Rolfe, in circuit court for the county of Lenawee, Mich., involving the ownership of the Rolfe pioneer self-soldering protector patents, a decision was handed down on February 4, in favor of the American Electric Fuse Company.' . . . . The facts of the matter are as follows: the American Electric Fuse Company claimed to have a royalty contract covering the Rolfe pioneer self-soldering protector patents. The contention of the Rolfe Electric Company and myself was that the American Electric Fuse Company had violated its contract with us, and the same was no longer valid. The action was brought by the Rolfe Electric Company and myself for the purpose of determining the validity of the contract. The court sustained the contention of the American Electric Fuse Company, holding that the contract was still in force. Should the contention of the American Electric Fuse Company finally be sustained, nevertheless, the ownership of the patents remains in the Rolfe Electric Company and myself, and the American Electric Fuse Company will be required to pay the royalties as provided by the contract, which they have repeatedly offered to do heretofore. I trust that in your next issue you will correct the impression given by the legal item to which I have referred, as the statement coming from your paper is very damaging to the Rolfe Electric Company and myself. One of the reasons why it is damaging is that, as you know, I have patents or applications for patents upon many forms of protectors, other than the self-soldering and those who are not informed in respect to the matter may think these were involved in the litigation. All the patents involved in the litigation constitute but a very small part of the patents owned by me, and the only right which I ever gave in respect to the patents involved in the litigation were the right to manufacture on payment of royalties from year to year. Signed, Charles A. Rolfe." This is the information that the item in question was intended to convey. The American Electric Fuse Company entered into a contract with the Rolfe Electric Company and Charles A. Rolfe to manufacture under exclusive rights. The Rolfe company contended that this contract had been violated, but the court held that this was not the case.

INDUSTRIAL ITEMS.

THE NERNST LAMP COMPANY, Pittsburg, Pa., is distributing a series of monthly bulletins calling attention to its product.

THE NATIONAL CABLE AND WIRE COMPANY announces that on March 1, 1905, it removed its general offices from Pittsburg, Pa., to the manufacturing plant at Shousetown, Allegheny County, Pa.

PARTRICK, CARTER & WILKINS, Philadelphia, Pa., have moved to a new factory at Twenty-second and Wood streets, where they have doubled their floor space and facilities, and are prepared to meet the constantly increasing demand for a full line of their exclusive specialties.

THE PEERLESS ELECTRIC COMPANY, Warren, Ohio, is distributing folder No. 1, vol. ii, of its series of leaflets, calling attention to the application of Peerless motors to the individual driving of printing-presses. In addition to the leaflet there is a mailing card, which renders easy an application for further information.

THE CHICAGO FUSE WIRE AND MANUFACTURING COMPANY, Chicago, Ill., is now established in new and commodious New York city offices, at 203 Fulton street. This move was made to enable the company to serve its customers with greater promptness, and also to secure more room and added facilities. Telephone call, 6056 Cortlandt.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., in pamphlets Nos. 051 and 052 describes and illustrates the Hunt industrial railways and the general line of machinery manufactured by the company. The company is also distributing a paster designed for convenient insertion in the handbook, consisting of a conversion table.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., announces that it is completing one of the finest tollboards that it has ever turned out for the United States Telephone Company, for use at Toledo, Ohio. The board consists of five sections of three operators' positions each, and is equipped throughout with the most modern apparatus.

THE NATIONAL BATTERY COMPANY, Buffalo, N. Y., will be pleased to send to those interested a handsome catalogue descriptive and illustrative of its unit accumulator. This accumulator has been built especially for high-charge and discharge rates, with long life and high efficiencies. These results are obtained with a positive Planté plate, and a negative of the Faure type.

THE AMERICAN ELECTRIC FUSE COMPANY, Chicago, Ill., is distributing an attractive booklet calling attention to the Kaisling protector. This booklet is profusely illustrated, and the different forms of Kaisling apparatus are described in detail. This company is very enterprising, and is a persistent seeker for business. During 1905 it expects to increase very largely its protector business.

THE BARRIETT ELECTRIC COMPANY, Cincinnati, Ohio, announces the decease of Mr. S. L. Barriett, president of the company. The announcement is made that the death of Mr. Barriett will in no way interfere with the carrying on of the business of the company. The factory is in active operation, having a full volume of business. Orders are being received daily, and filled promptly.

THE STANDARD VARNISH WORKS, 29 Broadway, New York city, is mailing a folder calling attention to the three varnishes which it makes especially for electrical repair work. These are, respectively, "Voltalac," an all-around repair work varnish, black in color and especially made for insulating and repair work; "Gutta-Percha" black finishing varnish for repair work, and "Gutta-Percha" light finishing varnish for repair work.

THE COMMERCIAL ELECTRICAL SUPPLY COMPANY, 1007 Market street, St. Louis, Mo., is calling attention to the Colonial direct-current ceiling and desk fans for the season of 1905. The company will be pleased to send descriptive matter upon request. Another specialty to which the company is calling attention is the Monarch improved incandescent lamp, made by the Monarch Electric Manufacturing Company, of Warren, Ohio.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has recently opened a new office in Chicago, at 1107 Fisher Building, and has arranged with Mr. C. H. Norwood to represent it in the Chicago territory in its line of "Standard" motors and generators. The company will carry a complete stock of these goods in Chicago. Mr. Norwood is a man of wide experience and recognized ability, and will make a good representative.

THE ARNOLD ELECTRIC POWER STATION COMPANY, Marquette Building, Chicago, Ill., is issuing a pamphlet descriptive of the Chicago & Milwaukee Electric Railroad extension. This is Arnold bulletin No. 11. The bulletin is handsomely illustrated, and gives an accurate description of the mechanical details and physical features of the system. The Arnold Electric Power Station Company is engineer and contractor, and undertakes specifications and contracts for power-house expansion.

THE BERGMANN ELECTRICAL WORKS, Berlin, N., Germany, will be pleased to send its elaborate new export catalogue No. 8-E to any one interested in electrical supplies. This catalogue contains 234 pages of illustrative and descriptive matter, dealing with conduit tubes, switchboards, switches, cutouts, lamp-holders and other devices. Prices, dimensions and shipping weights are also quoted. Other price lists in English, German, Spanish and French may be secured by addressing department "J," 33-35 Hennigsdorfer strasse.

THE MICHIGAN CENTRAL RAILROAD COMPANY is distributing a new California and Colorado folder, giving detailed information concerning its through-car service from eastern and western connections at Chicago. This folder is splendidly printed and embellished with numerous illustrations of typical scenes in the country which the service covers. The cover page is printed in colors, and represents a portion of an orange bough, both in blossom and in fruit. This folder may be secured by writing to W. H. Underwood, general eastern passenger agent, 486 Ellicott square, Buffalo, N. Y., or to O. W. Ruggles, general passenger and ticket agent, Chicago, Ill.

THE BALL & WOOD COMPANY, Elizabethport, N. J., is adding a new department to its business—that of flange welding and pipe bending. The increasing use of high-pressure and superheated steam has developed the need of pipe joints which are absolutely reliable, and in the process the company is bringing out, the use of forged-steel flanges welded to the pipe will eliminate weak spots in the steam joint, the pipe and flange being made homogeneous. Contracts have been let for a new smith-shop at the Ball & Wood works, for the purpose of doing this work. It is expected that the shop will shortly be in full operation. Mr. O. M. Jones has resigned his position in the New York sales office of the National Tube Company to become the manager of the new department of the Ball & Wood Company. Full information may be secured regarding this work by addressing the Ball & Wood Company, welding department, 17 Battery place, New York city.

THE CENTRAL ELECTRIC COMPANY, 209 East Jackson Boulevard, Chicago, Ill., has established a record for quick recovery from adverse circumstances. As was announced last week the plant of the company was destroyed by fire on the morning of Saturday, February 11. The new quarters at 209 East Jackson Boulevard were arranged for within one hour after the regular time for opening the office. Before noon complete office equipments, including typewriters, desks and new stationery, had been secured. By ten o'clock the same night 10,000 announcements had been distributed to the trade, calling attention to the excellent condition in which the company had placed itself for the prompt execution of all orders. The company states that it is now in a position to make good all promises of prompt attention to orders and enquiries. Normal conditions are restored, and save the effect of new surroundings, business is moving forward in natural channels. The company is sending to the trade a small booklet giving views of its present location, and thanking the members of the electrical fraternity for their generous and practical sympathy, which helped to sustain the company under the trying conditions following the disastrous fire which involved the destruction of its long-established plant.